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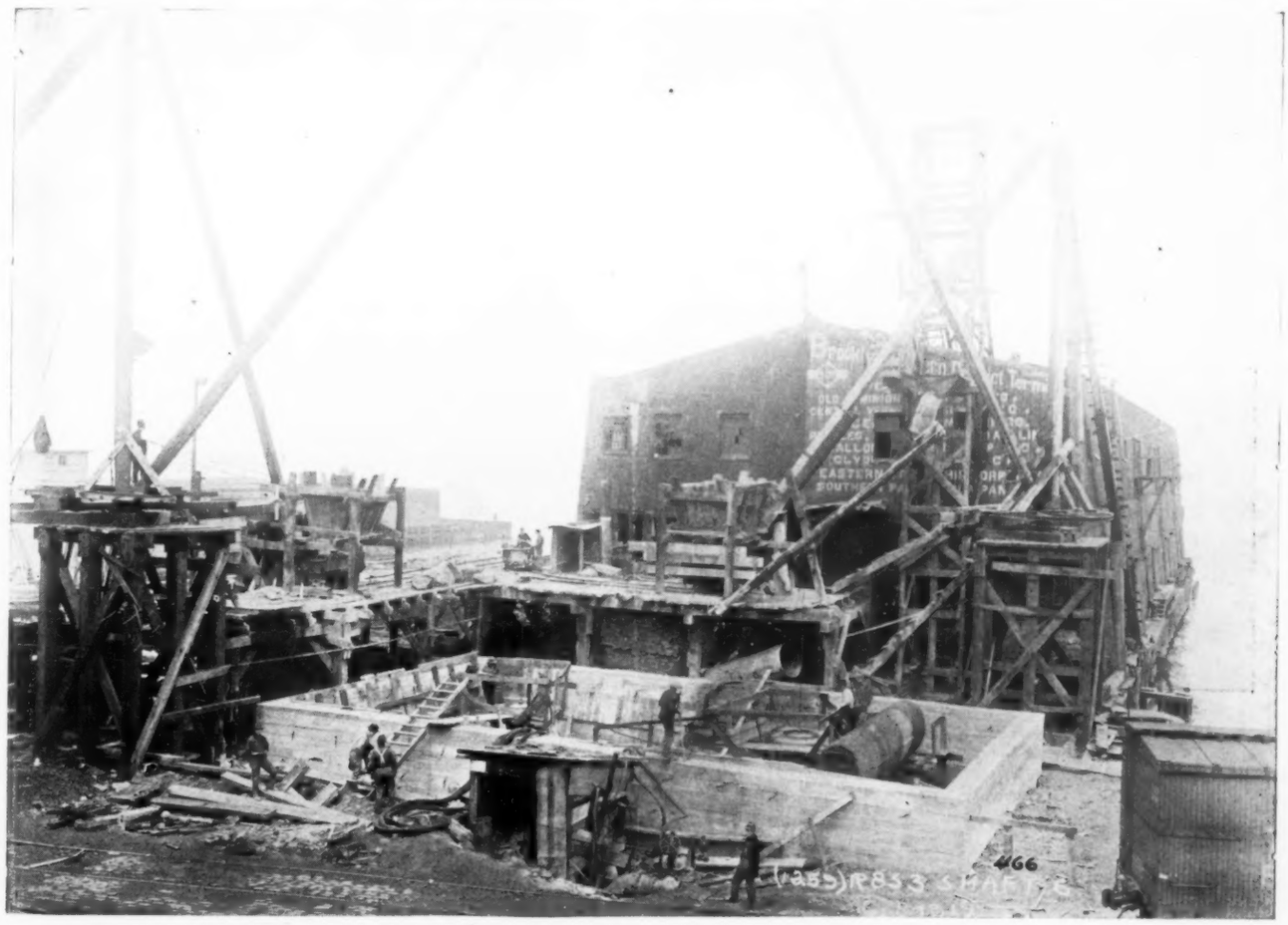

TOP OF FINISHED DOUBLE SHAFT FOR 14TH STREET TWIN TUNNEL TUBES. HORIZONTAL EMERGENCY LOCK AND TOP OF MAIN SHAFT AT RIGHT, MUCK LOCKS AT LEFT AND CENTER OF CAISSON

IN THIS ISSUE

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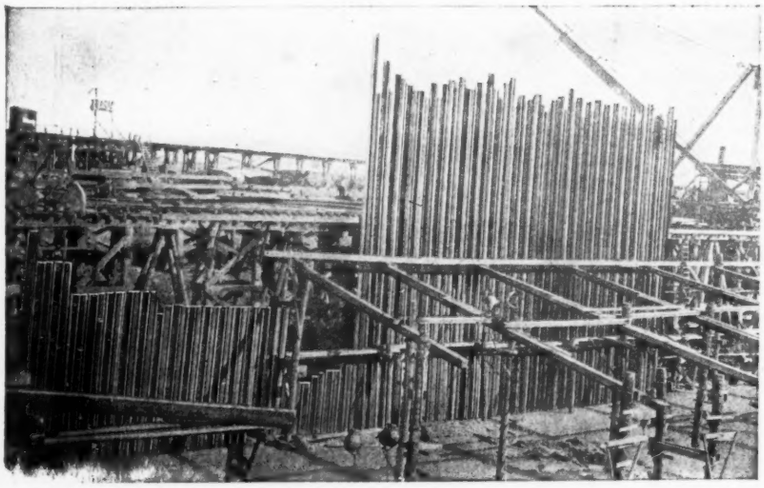
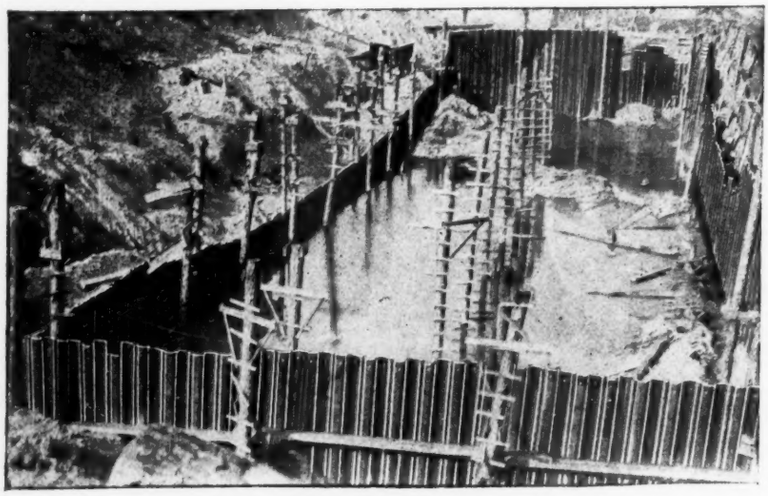
Pneumatic Caisson Tunnel Shafts

NEW YORK, JUNE 19, 1920

Lackawanna Steel Sheet Piling Cofferdam

For Building U. S. Government Dry Dock, No. 4, Norfolk, Va.





The cofferdam in which the outer or gate section of this dry dock was constructed consisted of 14-inch by ⅜-inch Lackawanna Arched-Web Sheet Piling in 40-foot and 65-foot lengths.

The original boring indicated materials to be sand, shells, clay and muck, very unstable and apt to be very porous.

The preliminary excavation was completed, temporary timber forms set and the steel sheet piling assembled around these forms complete. The closure was then made and the walls were driven to refusal. The 65-foot steel sheet piling lengths were cut off at the dock floor level and the bottom ends left in position as a permanent protection wall for the outer end of the dry dock. This dry dock was flooded for the first time February 1, 1919.

The pictures show the uniformity to which even very long lengths of Lackawanna Steel Sheet Piling can be driven and also that complete assembling around temporary forms before starting to drive is a great help in securing this uniformity.

If you have any cofferdam problem where our advice as to correct choice of sheet piling section, watertightness, best form of bracing, etc., would be helpful, you have but to state the requirements and our engineers are at your service free and freely.

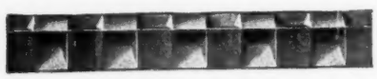
DOUBLE-LOCK LACKAWANNA INTERLOCK

A three-line positive watertight joint contact with greatest tensional strength.

We Also Offer for Better Construction

Elcannes

Concrete Reinforcing Bars



The Elcannes Bar combines maximum bonding surface, minimum weight, and uniform strength. The bonding surface is 15 per cent greater than that of a plain square bar of equal nominal size. The cross-sectional area is practically the same at all points and the regular surface facilitates frabrication and handling.

Lackawanna Steel Company

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For Great Britain and British Colonies in the Eastern Hemisphere, Cargo-Fleet-Iron Co., Ltd., Middlesborough, England. For France, Italy, Spain, French Colonies and Protectorates, Italian Colonies and Spanish Colonies in the Eastern Hemisphere Cie Des Forges & Aciéries de la Marine et d'Homécourt, Paris, France.

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PUBLIC WORKS.

CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL AND PUBLIC WORKS" and "CONTRACTING"

Vol. 48 NEW YORK, JUNE 19, 1920 No. 23

Big Eddy Storage Dam* II

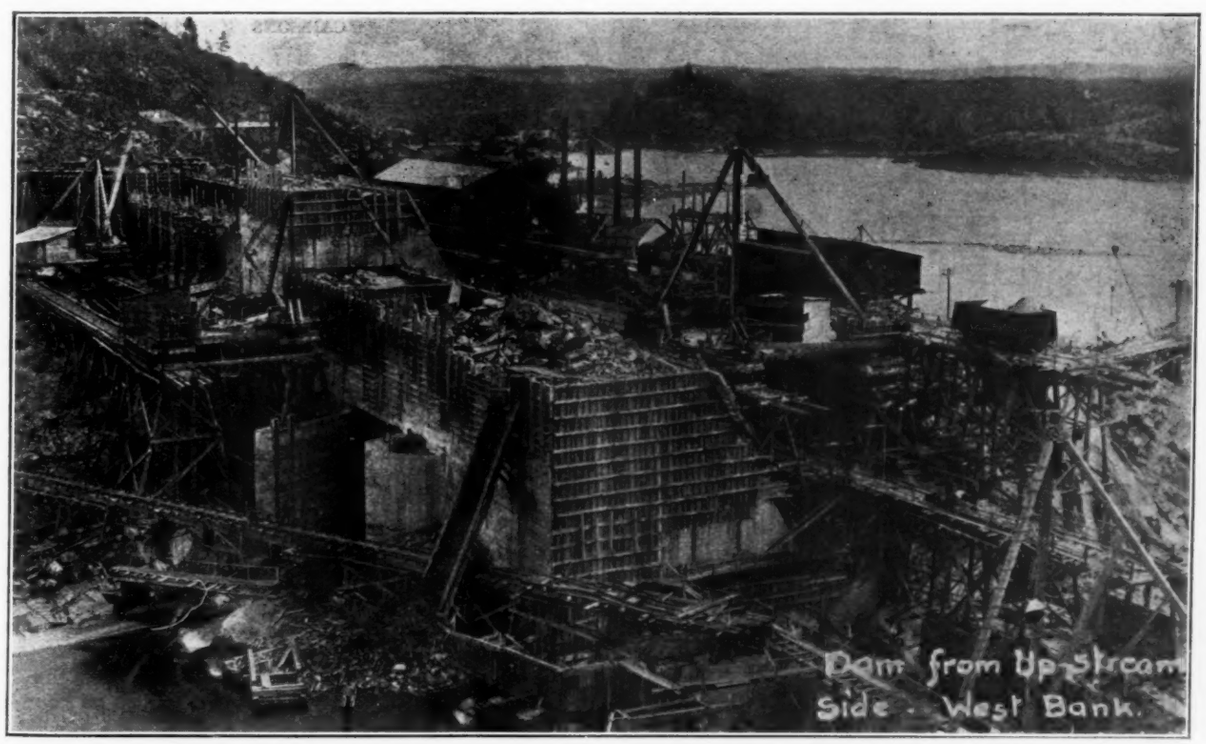
Pneumatic caisson foundations forming part of main structure served also as elements of cofferdams excluding river from footings, and were built on suspended platforms and lowered to position. The mixing plant was installed on shore and 88,000 yards of concrete delivered on trestle service tracks and handled by stiffleg derricks.

The Big Eddy dam across the Spanish river at Turbine, Province of Ontario, Canada, is, as described in the previous article, a monolithic concrete structure, 1,100 feet long and 159 feet high, with a gravity cross-section about 100 feet wide at the base. It was built in swift water on an exceedingly irregular rock bottom, which had first been explored and partially levelled by submerged drilling, blasting and divers' work before commencing the main structure. This involved unusual difficulty and expense and was executed with great courage and determination and the use of some unusual expedients and executed by Fraser, Brace & Co., the contractor.

*Part 1, giving general data, plan and cross-section of dam with description of location, construction of connecting railroad, building camp, installing of power plant, excavation of by-pass channel and preparation of river bottom was published in Public Works, April 17, page 319.

DIFFICULTIES ENCOUNTERED

The severity of the climate, the quantities of heavy ice carried in the river, and the rough and jagged rocks forming the bed of the deep, narrow river, were a few of the difficulties that were provided for by the preparation of complete plans in

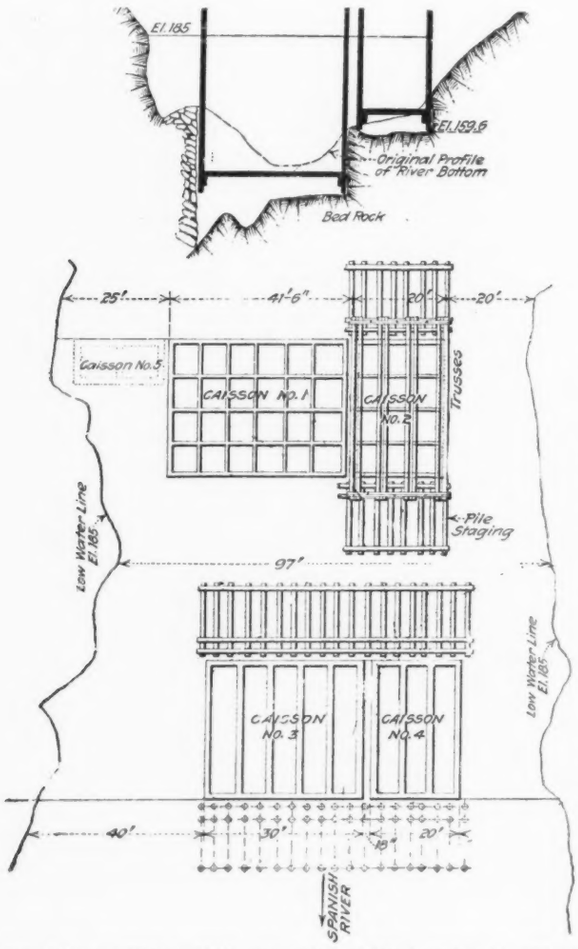


UP-STREAM SIDE OF DAM, SHOWING CONCRETE FORMS, TRAVELING DERRICK ON UPSTREAM AND DOWN-STREAM TWIN TRESTLES, AND LOW-LEVEL SERVICE TRACKS.

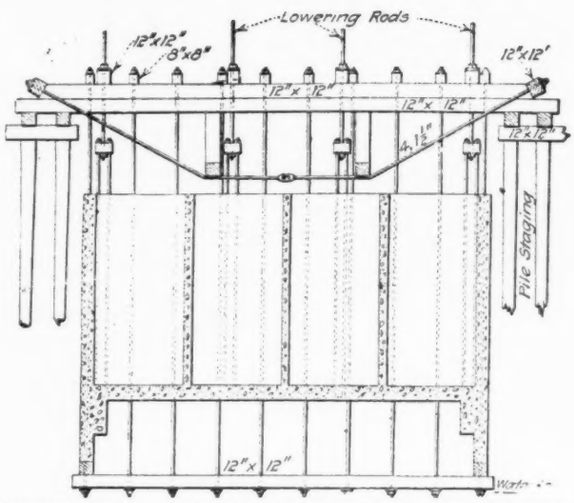
advance which were closely adhered to and successfully carried out, enabling the work to be done approximately on scheduled time, notwithstanding the many uncertainties and the development of conditions as the work progressed that could not be accurately foreseen.

The water, from 45 to 55 feet deep normally, had a low-water velocity of 4 miles per hour and the bottom, covered by 30 feet of boulders, was so hard that it could not be penetrated by piles or by ordinary excavation, and so jagged and irregular that cribs, caissons or other footings could not be fitted to it, thus making the construction of cofferdams to enclose the site a dangerous and difficult problem.

As the low-water width of the river at the dam is only from 100 to 120 feet, there was no room to build the dam in successive sections, allowing the water to flow through one portion of the original channel while construction was going on in the adjacent portion, and therefore it was built of separate units simultaneously constructed to form one continuous mass reaching from shore to shore, which was constructed within the protection of upstream and downstream cofferdams crossing the full width of the channel, the water being diverted meantime through an artificial by-pass channel previously prepared for it.



CAISSON FOUNDATIONS, UP AND DOWN STREAM SIDES OF DAM
Some of Lowering Trusses and Platforms Shown



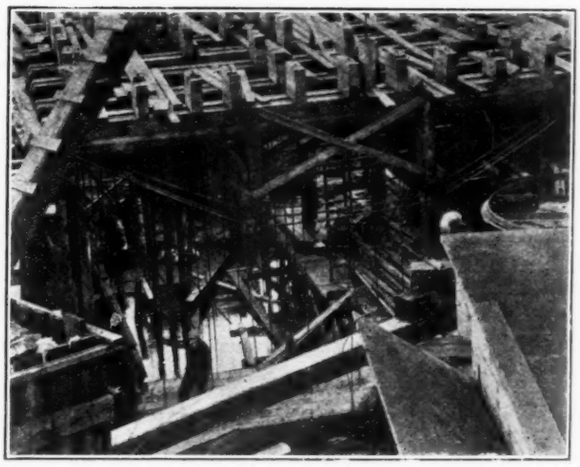
UNFINISHED CAISSON SUPPORTED ON PLATFORM SUSPENDED FROM LOWERING TRUSSES

As no ordinary form of cofferdam could be constructed or maintained in the deep, swift water of the rocky channel, it was determined to make the cofferdams consist substantially of pneumatic foundation caissons supplemented by temporary rock-filled timber cribs and sheet piling or sheeting. The penumatic caissons were located on the upstream and downstream edges of the foundation of the dam, and were designed and built in such a manner as to form part of the permanent concrete structure after they had served the purpose of excluding the flow of the river from the foundation pit.

CAISSONS

Reinforced concrete caissons from 20 to 40 feet long were therefore arranged in pairs as shown in the accompanying plan, Nos. 1, 2 (and afterwards 5) on the upstream edge, and Nos. 3 and 4 on the downstream edge. The narrow spaces between them were closed with sheet piling and, at the ends of the outer caissons, crib cofferdams were built to extend the cofferdams entirely across the channel. There was thus enclosed a space about 110 feet long between the upstream edge of the upper caisson and the parallel downstream edge of the lower caisson. This space was pumped out, enabling the bottom of the river to be prepared and concrete placed for the foundations of the dam, including and enclosing the five caissons, which were made of reinforced concrete strengthened by interior longitudinal and transverse bracing walls, dividing them into pockets which were subsequently filled solid with concrete deposited under atmospheric pressure.

The locations of the caissons were carefully sounded and platted and the bottoms were approximately levelled by drilling and blasting under water before the construction of the pneumatic caissons was commenced. As the caissons could not be launched, floated or sunk in the ordinary manner on account of the character of the bank and of the river and its bottom, they were built in position directly above their respective sites and lowered, under control, to the bottom of the river, after which air pressure was put on and they were sunk to the required depth in the ordinary manner.



CAISSON PLATFORM SUSPENDED FROM LOWERING TRUSSES

All of the caissons were built and sunk in the same manner as caisson No. 2, which in the plan is shown suspended under a set of four supporting trusses, parallel to the axis of the river, with their ends resting on pile stagings just clear of the up-stream and downstream faces of the caissons. In this view the pile stagings are simply represented as timber frameworks similar to the one shown just upstream of caissons 3 and 4, and not showing the group of supporting piles under the timbers which, however, correspond with the piles shown at the downstream ends of caissons 3 and 4, where a portion of the piles and all of the timber framework are omitted. Similar stagings were provided upstream and downstream of caissons 2 and 5, but are not shown in the plan.

Each staging is composed of several six-pile bents framed and braced on shore and set in position by the 50-foot and 60-foot booms of two stiffleg derricks on each shore, which together commanded nearly all of the cofferdam area.

As the piles could not penetrate the rocky bottom, no attempt was made to drive them, but stability was secured by bracing them thoroughly in both directions to form towers, and by divers packing cement bags around their lower ends.

SUSPENDED PLATFORMS

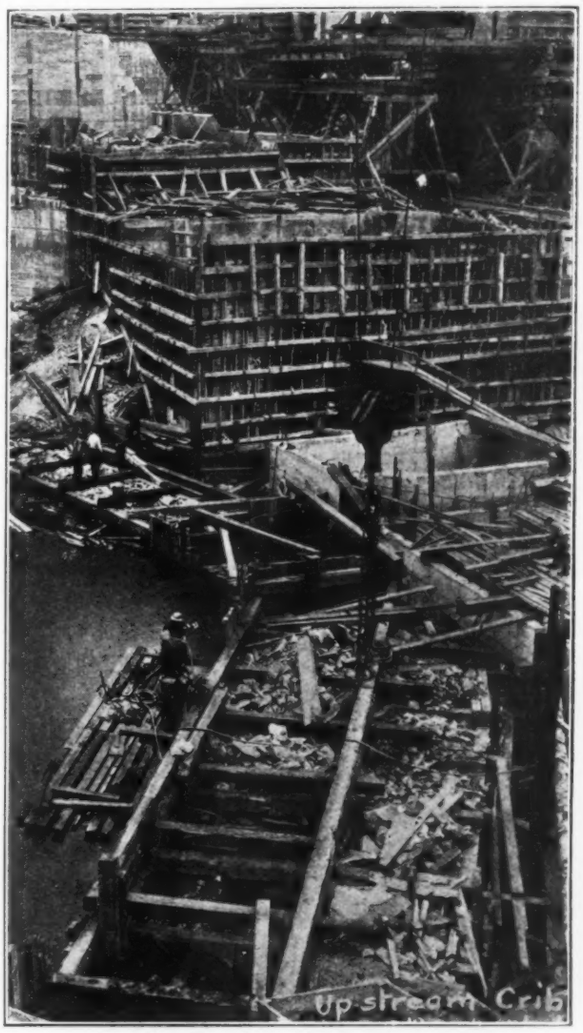
The upstream and downstream pile stagings for each caisson were connected by several double Howe trusses, each having the top chord made of two 12x12 inch full-length timbers and the bottom chord composed of four sleeve-nut connected 1½-inch diameter bent rods. Between the trusses of each pair there were placed 10 vertical 2-inch rods about 3 feet in length, with nuts and washers at both ends. The upper washers took bearing on saddle pieces seated on the top chords of the trusses, and the lower ends supported beams at water level, which beams carried a working platform on which the cutting edge of the caisson was assembled.

The exterior form, consisting of panels 8 feet high made of 2-inch planks nailed to 3-inch transverse pieces, was erected on the riveted structural steel cutting edge; and the off-set inside form was erected on the suspended platform concentric with the cutting edge. The caisson was concreted, a solid roof for the working chamber being constructed, and interior cross walls above it. The walls, about 6 feet apart in both directions, were concreted in collapsible forms with vertical joints made with removable fillers.

Pairs of 2-inch vertical rods were built into the walls of the caisson and projected above them, with nuts on the upper ends engaging yokes suspended from the lower ends of the lowering rods that passed through the top chords of the trusses and took bearing on them.

LOWERING CAISSONS

After the first course of the caisson had been concreted, completing the working chamber, the platform planks were removed, leaving the timbers in position, and the nuts on the lowering rods were turned to let the working chamber down into the water. This provided clearance under the supporting trusses for the addition of another course of forms and concrete which, in turn, were lowered, and so on, until the cutting edge took bearing on the bottom of the river; after which the tops of the caisson walls were concreted as the caissons were sunk to position by interior excavation under air



CRIBS AND CAISSONS ON UP-STREAM SIDE OF DAM

WASHING No. 3 CAISSON FOUNDATIONS WITH HOSE

pressure. The same process was followed with the other four caissons. Notwithstanding the preliminary leveling, the bottom was so irregular that, in some places, cement bags placed by divers were built up to the cutting edge and a large amount of clay was necessary for sealing the caissons. Most of the rock was very hard, but in some places it was softer.

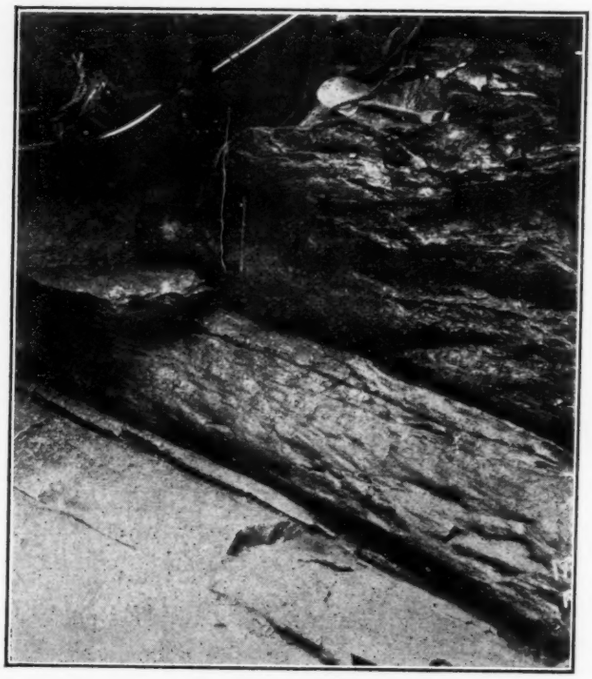
As the timber skeleton for the working platform, on which the cutting edge was erected, was not removed when the floor planks were, it afforded an excellent scaffold for men drilling and blasting the rock bottom and boulders with jackhammers and tripod drills, the steel for which in some cases had to be sharpened for every 3 inches of penetration. The adjustment of the lowering rods was facilitated by the use, at the upper end, of brass nuts bearing on well oiled steel plates, which reduced the friction sufficiently to enable them to be slacked off by two men with a long-handle wrench. Nuts at the lower ends had bearing on permanent channel saddles embedded in the concrete.

The caissons were put under air pressure on December 15, 1918, and although the temperature fell during the winter to as low as 28 degrees below zero, the season was considered a mild one for that locality, and work was prosecuted continuously and pneumatic pressure maintained until March 17, 1919, when the caisson sinking was completed. Some difficulty was experienced from the formation of frazil ice, which accumulated on the pile bents and so obstructed the channel as to form a sort of dam, raising the surface of the water on the upstream side 4 feet higher than that on the downstream side. The caisson forms were protected from cold by tarpaulins and the interiors were heated by salamanders which maintained a temperature high enough to prevent danger of the concrete freezing.

CONCRETING

The aggregate was made with sand, gravel and slag, the last being excavated about 25 miles from the dam site in a pit owned by the Nickel Company. It was drilled and blasted with black powder, which broke it into pieces with a maximum diameter of about 3 inches, which were excavatel by a steam shovel that at first loaded it into standard gage Hart-Otis cars, in which it was transported to the mixer plant.

The sand and gravel were excavated in a pit about 12 miles from the dam site by a Marion No. 60 steam shovel, which delivered to dump cars similar to those carrying the slag, which deposited their contents in storage piles on the surface of the ground. From these, as required, it was loaded into



STRATIFICATION OF BED ROCK IN FOUNDATION OF No. 3 CAISSON.

measuring dump cars which discharged directly into the hopper of ¾-yard concrete mixers, which very easily provided the required output of 100 yards a day that sufficed for the caisson construction except when the working chambers were being filled. The total amount of concrete required for the caissons was delivered by derricks located so as to empty the buckets into the nearest caissons with a single movement, and into the most remote ones by two movements.

CONSTRUCTION PLANT

After the completion of the caissons, the remainder of the winter, before the ice broke up in the spring of 1919, was utilized in the installation of the construction plant for mixing and handling the 78,000 additional yards of concrete required. A double-track railroad trestle was built to the mixer plant near the end of the dam on the east bank of the river, where storage was established for aggregate and cement and two 1¾-yard Ransome steam-driven mixers were installed.

The previously mentioned slag from the smelter at Copper Cliff and the sand from the pit were delivered in 35-yard Hart-Otis cars to the storage bins above the mixers. Cement in bags, which were

stored in the adjacent shed, was delivered to the mixer through chutes. The gravel and slag were discharged into measuring hoppers set over the mixers, to which was added cement delivered by the chutes on signal by an electric bell. The mixers discharged the concrete into elevator buckets, in which it was hoisted and dumped into elevated hoppers just above the service track on the concrete trestle. On this track there were installed small flat cars carrying 1-yard buckets which were spotted under the hoppers and, when loaded, were hauled by a hoisting engine and cable to derricks, which unloaded the buckets from the cars and dumped their contents where required.

TRACKS AND TRAVELERS

Twin trestles, parallel to the axis of the dam, were built adjacent to both the upstream and downstream faces of the dam, and on each were installed two standard-gage tracks 25 feet apart on centers. On each of these pairs of tracks there were provided two movable stiffleg wooden derrick travelers

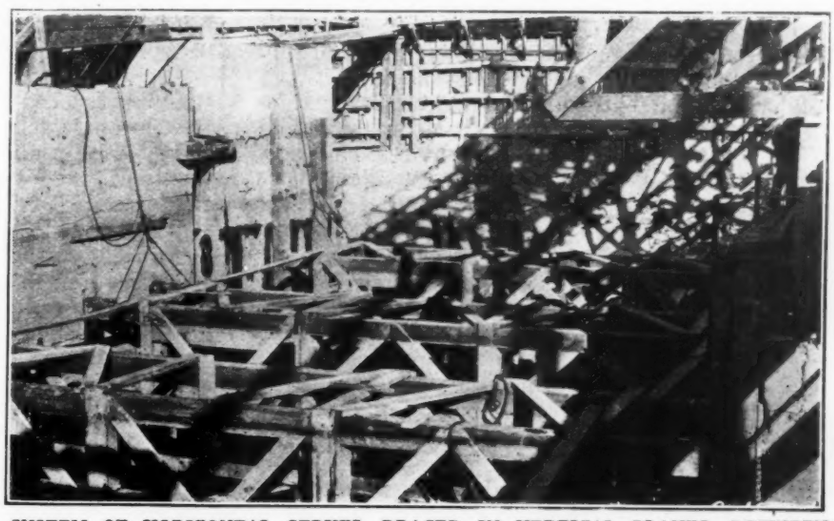
CUTTING EDGE OF No. 1 CAISSON EXPOSED BY EXCAVATION INSIDE COFFERDAM

with booms 60 and 70 feet long commanding the entire area of the dam and serving to handle all of the concrete, Cyclopean stones, and excavated material as well as the forms and any part of the equipment for construction material. The elevation of these tracks was about 50 feet below the crest of the dam and about 50 feet above low water level in the river. Adjacent to the downstream trestles was a lower trestle carrying two narrow-gage tracks for the concrete cars at an elevation of 35 feet above low water. On the upstream sides of the dam another trestle carried the two narrow-gage tracks on which Cyclopean stones or plums were delivered. These delivery tracks were built on a slight grade downwards with the loaded cars and were served by hauling ropes operated by hoisting engines to pull the empty cars back to the mixer and to the storage pile.

COFFERDAM CRIBS

As the caissons did not extend across the full width of the river, on either the upstream or downstream face of the dam, it was necessary to supplement them by cofferdams filling in the open spaces on the shore sides of caisson 3, 4, 2 and 5. These cofferdams were ordinary cribs built of square timber with rock-filled pockets. The downstream faces of the upstream cofferdams were set approximately in line with the upstream faces of the upstream caissons, and similarly the downstream cofferdams were set outside the foundation area so that, in both cases, the cribs could take bearing against the faces of the massive caissons, thus affording them support, which gave stability without requiring such large dimensions as would have been necessary if the cribs were independent structures. They were accordingly made with comparatively narrow widths, which proved adequate.

By June 15, 1919, the water in the river was low enough to permit the commencement of the cofferdam work. A full-size timber template was made and placed in the exact location of each cofferdam and soundings 2 feet apart were made from it and platted to give a profile of the bottom, to which the framing of the lower courses of the crib was made to conform. The largest crib, in water 38 feet deep on the west end of the upstream face of the dam, was 22 feet wide. At the east end, in 28 feet of water, the crib was 15 feet wide; and on the downstream side of the dam, in 38 feet of water, the cribs were 20 feet wide. The cribs were sunk to position and fitted satisfactorily on the irregular bottom. The faces were covered with sheet piling nailed on by divers, who also nailed to the bottom of the sheeting an apron of drier felt which extended outwards and rested horizontally on the river bottom and was covered by fill dumped in from above, holding it securely in position and protecting it.



SYSTEM OF HORIZONTAL STRUTS, BRACED IN VERTICAL PLANES, BETWEEN UP-STREAM AND DOWN-STREAM CAISSONS

UNWATERING AND EXCAVATING

Pumping was commenced September 2, 1919, and about two days afterwards excavation was commenced between the upper and lower cofferdams where the general surface of the rock sloped from the east to the west side approximately parallel with the axis of the dam. A seal was formed on the upstream side between the caisson and the east bank. Considerable excavation was required between the upstream caisson No. 1 and the bank before solid foundation was reached and, the rock being in almost vertical strata, the working space was very small.

As the cutting edge of the west side of the caisson was not sunk to solid rock, it was necessary to excavate below it and remove the loose rock to a depth of 15 feet. When this was done the exposed concrete in the working chamber was found in perfect condition and was later thoroughly bonded with the fresh concrte placed on the rock surface. However, the space between the rock and the face of the caisson was so small (only 4 feet wide at the bottom) that it was sealed with concrete placed under water through a tremie, and when after 9 days it was unwatered, it was found to be perfectly tight under a head of 20 feet.

In the construction of the two downstream caissons, No. 3 and 4, the upper parts of the upstream walls were built of timber instead of concrete above elevation 161 and 170, and after the pockets in the upper portion of the caissons had been concreted, the timber walls were removed, leaving spaces in which there were installed two 12-inch centrifugal pumps at an elevation of 22 feet below normal water level.

As the cofferdam was unwatered, heavy horizontal timber struts were set between the upstream and downstream caissons to brace them against external pressure, and when the natural surface of the river bed had been uncovered, all loose material was excavated and the sound rock was thoroughly scraped and washed with heavy hose pressure. The material excavated was shovelled by hand into 1-yard wooden skips and removed by the derricks to flat cars on the service tracks and transferred to spoil banks above the dam, where it was dumped in the river bed.

Concreting was commenced on the upstream side of the dam and the concrete was placed between bulkheads before excavation had been completed on the downstream side. The concrete in the center of the mass was a 1:3:6 mixture, and on the faces 1:2½:5 mix was used. The use of slag for concrete aggregate increased the weight from 145 pounds, which would have been produced with a rock aggregate, to 170 pounds per cubic foot.

As a precaution against uplift pressures, holes 20 feet deep were drilled every 10 feet in the river bed, pipes were inserted in them and, when the concrete had been brought up to the proper elevation, they were connected to a header carried out to the downstream face of the dam, thus affording a vent for any possible leakage.

Above the tops of the caissons the dam was built in sections with forms made of heavy wooden panels, 8 feet high, of the cantilever type, which were anchored at the lower part to the solid concrete and were strong enough to resist the horizontal pressure of the wet concrete above. These panels were handled by the derricks, which shifted them from below upwards as the work progressed. About 7,000 yards of concrete on the average was placed each month, after June, 1919. The maximum number of men empoyed at one time was about 700, of which 150 were sand hogs.

Georgia's New Road Contract

A form which the State Highway Department is intending to try out, involving an estimate by the contractor and a fee or profit varying inversely as the actual cost.

In an effort to protect the contractor and to get the work of road building more nearly in line with ordinary business methods, the Georgia Highway Department is working out a new form of contract which it is expecting to use this season. Briefly stated, the contract provides for payment to the contractor on a basis of unit costs estimated by him, to which he adds the lump sum amount which he expects to make as his profit. If the total cost of the work as constructed should be less than his estimate, the contractor will receive 25 per cent of the difference between the actual cost and his estimate of the cost, such additional payment, however, not to exceed 50 per cent of the sum originally estimated as profit. On the other hand, if the actual cost should exceed the estimated cost, 25 per cent of such excess cost will be deducted from the sum originally estimated as profit, this deduction not to exceed 50 per cent of such estimated profit; that is, no matter what the cost of the work, the contractor is sure of at least half of his estimated profit.

To illustrate the working of this system, suppose the contractor submits an estimate of actual cost of a piece of work as $100,000 and asks a fee of $10,000. Then if the actual cost of the work should prove to be $110,000, the contractor's fee would be reduced to $7,000, and if it should be $120,000 or more, the fee would be reduced to $5,000. If, on the other hand, the actual cost should prove to be only $90,000, the contractor would receive $12,500, and if the cost should be $80,000 or less he would receive $15,000 as his fee. This fixed sum spoken of as the contractor's fee is to provide for the services rendered by the contractor in providing his purchasing facilities, skill and experience, ability to organize a force, and the use of his equipment, tools etc. With the bid the contractor must submit a list of the equipment which he intends to use.

The contractor is supposed to figure out his unit costs on all the items entering into the job, such as clearing, earth excavating, concrete work, etc. The various unit costs are combined and the total is called the cost of the work. That total is the figure

which the contractor tries to beat in order to get his extra compensation. Payment is to be made as the work progresses, on monthly statements on items included in the cost of the work. If, during construction, it becomes evident that changes in the specifications are necessary or that decreased or increased quantites of work must be performed, these changes will not count against the contractor when the actual cost is figured.

There is one other provision inserted for the protection of the county. Should a contractor so mismanage the work that, in order to protect the county, the State Highway Department would be forced to step in and take over the job, such power is given to the State Department. This provision seems to give the State Highway Department almost arbitrary power, but no other way was found for protecting the public. If the State Highway Department is conducted fairly and squarely, no fair and square contractor will suffer; while if the Department is not fair and square, the sooner that fact is discovered the better for all concerned.

In awarding a contract three factors are to be considered—the total amount of the bid, which is the estimated cost plus contractor's fee; second, the experience of the contractor, his financial backing and his record on other jobs; and third, his equipment. In comparing bids, the first item is given a weight of 65 per cent, the second item of 20 per cent, and the third item of 15 per cent. In considering the equipment, the size of the job will be considered and equipment which is too large and unsuitable for a small job will count no more in his favor than a plant which is too small for the job.

It is hoped by state highway engineer W. R. Neel that this plan will operate to protect the efficient contractor with a good record behind him and a good road building plant. These are the men whom Georgia wants to build her roads, and when she gets them working for her and with her she wants to protect them.

Renting Equipment to Contractors

The State Highway Commission of Montana early in May adopted a policy of renting trucks and other equipment to contractors. It was decided that only such equipment would be rented as is not otherwise requisitioned by counties, cities and towns, and that a deposit of $1,000 would be required for each truck, $1,500 for each 120 horse-power caterpillar, and for other equipment a deposit of approximately 20 per cent of its value. The rental rates were fixed as follows: For each truck $200 per month, for each 120 horse-power caterpillar $300 per month. Other equipment available for use of contractors to be rented on the basis of annual depreciation as calculated by the chief engineer.

No contractor may secure surplus war equipment until he has been awarded a contract on state work. Any equipment now being leased to contractors for use in connection with work previously contracted for may remain in their service until the completion of such contracts, after which the equipment will be subject to redistribution by the commission under the above terms.

Equipment shall be returned by contractors and at their expense to Deer Lodge on the completion of the contracts for which they were leased, or held by the contractor subject to the orders of the commission. The deposits above noted will be held by the commission as a guarantee of the safe return of the equipment in proper condition, allowing for reasonable wear. The commission will sell T. N. T. to the contractors at the rate of 15 cents a pound.

Effect of Soil on Highway Durability

The Bureau of Public Roads, Department of Agriculture, has started an investigation of the relation of soils to highway durability. Samples of soil will be taken at spots in the sub-grade of a highway where the road has begun to fail, the surrounding geological conditions being studied with a view to determining how moisture arrived in the sub-grade, laboratory tests being made to learn the physical characteristics of soils and a scientific measure being obtained for their bearing value. It is planned to cooperate as much as possible with the various state highways departments and the Bureau of Soils.

Preliminary investigation is under way on the Washington-Baltimore road and will be extended beyond Baltimore and on other Maryland roads, and a number of samples of sub-grade material have already been subjected to laboratory investigation. It is expected that important information will be secured.

The Federal Highway council has asked both national conventions to put themselves on record on the subject of national policy and plan for further highway development. The council represents hundreds of farmers and organizations interested in highway construction.

It favors the appointment of a federal highway commission to coordinate the state work and have control of the national system. It believes that the government should take over about 60,000 miles, the states 240,000 miles and the counties 300,000 miles. The continuation of federal aid to the states is urged.

For National Transcontinental Traffic

The War Department, in a report to the Highways Committee of Congress, urged the development of the highways of the country to meet the needs or transcontinental traffic, this conclusion having been reached as a result of the Army convoy of seventy-three trucks, which blazed a trail from Washington to the Pacific coast last summer.

The recommendations of the department are as follows:

First—That the necessity for a comprehensive system of National highways, including through routes east, west and south, is real and urgent as a commercial asset to further colonize and develop the sparsely settled sections of the country and as a defensive military necessity.

Second—That the existing roads and bridges, especially in the sparsely settled sections of the middle and far western states, are incapable of meeting present-day traffic requirements, and until modern types of roads and bridges are constructed,

which will permit the rapid movement of heavy motor cargo vehicles during any season of the year and in all conditions of weather, economical transcontinental highway traffic will continue to be a vain hope.

Third—That the road problems of middle and far western states are national rather than local problems, as these states, while possessing vast area and tremendous mileage of highways, have only a sparse population, which cannot possibly undertake the needed highway improvement work, which, moreover, is usually of greater importance to the country as a whole than to the individual states.

Fourth—That the radius of action and resulting utility of the motor vehicle is limited only by the condition of the roads, and that the provision of adequate roads will have a far-reaching effect on the economic development of the country at large.

Fifth—That types of motor vehicles should be coordinated with road conditions, the size and weight of vehicles being limited to light and medium capacities, until all sections of the country are connected by highways passable to heavy motor vehicle traffic at all seasons of the year.

SUBWAY TO STATEN ISLAND

Transit Construction Commissioner Delaney, in a report to the Board of Estimate on the extension of the Fourth avenue subway under the Narrows to Richmond, considered six different possible tunnel routes to the island, as well as a bridge. He stated that $200,000 would be necessary to investigate the bridge project, while $50,000 would suffice for preparation of preliminary plans for either of two possible tunnels to Brooklyn to connect with the Fourth avenue subway system.

The cost of this subway extension is estimated by Mr. Delaney at from $20,000,000 to $25,000,000, but it is the quickest and cheapest way of bringing Staten Island into close touch with the rest of the city, and opening up a borough which affords room for the overflow from congested sections of the city.

Milwaukee's Activated Sludge Plant

Plans for a permanent plant for treating the sewage of the city have been tentatively agreed upon. The general features are described in this article, including those for dewatering and drying the sludge. Also some results of the five years' experiments, which have cost the city over $350,000.

The city of Milwaukee has been conducting for five years an experimental plant for studying the treatment of its sewage which is believed to be the most thorough and expensive investigation ever made by any one city in connection with sewerage or any other one municipal utility. Several articles and shorter references to this experimental plant have been published by us, chief interest being centered in its experimenting with and development of the activated sludge process. In addition to this, however, it has included in its operation experimental installations of grit chambers, fine screens, Imhoff tanks, trickling filters of various depths, colloidal slate filters, chemical precipitation, chlorination, electrolytic chlorination without lime, aeration by the draw and fill method, air applied for oxidation with mechanical mixing, reaeration of sludge, sludge drying, sludge dewatering, and numerous other minor investigations.

After about two years' experimenting, T. Chalkley Hatton and the sewerage commission of which he is chief engineer had practically decided that the activated sludge process was the one best adapted for Milwaukee conditions. Before building the five-million dollar plant, however, they employed Harrison B. Eddy as consulting engineer, who, in the latter part of 1917, recommended further investigations before final preparation of plans, and the commission rebuilt its experimental plant with a view to making more definite determination of certain points. The plant so modified was operated continuously for over a year with a fluctuation in flow of sewage corresponding to that which is expected to reach the final plant.

With this additional information Mr. Eddy recommended the activated sludge process for Milwaukee and the commission directed the chief engineer to prepare final plans and specifications to permit the earliest possible construction of the plant. The total investigation of the activated sludge process, together with the comparative operation of other processes, has cost the city more than $350,000; but this is only 7 per cent of the estimated cost of the final plant, and there can be little question that the information obtained during the investigation will be worth much more than this in securing additional effectiveness of the plant and will permit the saving of more than this in the actual cost of a plant adequate for the work.

PLANS FOR THE FINAL PLANT

The plans for the final plant have been tentatively agreed upon, and are based upon an average flow of sewage of 65,000,000 gallons per day in 1922, increasing to 129,000,000 gallons in 1950, these quantities being increased to 67,000,000 and 130,000,000

respectively for average flow including storm water, with 98,000,000 and 192,000,000 respectively as the *maximum* dry weather flows and 147,000,000 and 231,000,000 respectively as the maximum flow including storm water.

While about 90,000,000 gallons of the 1950 flow will reach the plant at a minimum elevation of 8.5, about 40,000,000 gallons at that date will reach the plant 25 feet below datum and will have to be pumped, the maximum rate of this low-level sewage being estiamted at 51,000,000 in 1922 increasing to 65,500,000 in 1950. This low-level sewage will first pass through cage screens with vertical bars spaced two inches apart. It will be lifted by three 30,000,000-gallon electrically driven centrifugal pumps automatically controlled by electrical contact from a float in the suction well, the pumps delivering the sewage into the main conduit, where it will combine with the high-level sewage. which has previously been passed through a grid screen with vertical bars spaced 3 11-16 inches apart.

The combined high level and low level sewage will then pass through a grit chamber divided into eight parallel compartments controlled by sluice gates hydraulically operated. These are so designed as to give a velocity through them of from 0.64 to 1.0 second-feet.

From the grit chamber the sewage will pass to fine screens containing slots 3-32 of an inch wide and from 2 to 2½ inches long, which are to have a capacity of passing 130,000,000 gallons per day under a 4-inch loss of head and 320,000,000 gallons of combined dry-weather and storm flow under a 12-inch loss of head. The screenings are to be removed by brushes and delivered upon a belt conveyor.

From here the sewage will pass into and through aerating tanks which will be approximately 340 feet long, 22 feet wide and 15 feet effective depth. Extending across each tank at right angles to the flow will be gutters, space 4.5 feet between centers, in the bottoms of which gutters will be filtros plates. In these aerating tanks, activated sludge will be mixed with the raw sewage and the two aerated together, after which the aerated mixture will flow through conduits into sedimentation tanks 75 feet square on top, 72 feet on the bottom and 15 feet in effective depth. Each tank will have a bottom slope of approximately 18 inches and will be equipped with a Dorr thickener or similar device for removing the precipitated sludge continuously to a central outlet in the bottom. The velocity of flow through the sedimentation tanks is not to exceed 1.5 feet per minute.

The effluent from the sedimentation tanks will flow over weirs into the outlet, which will discharge it into the lake near the harbor entrance, where the water has a depth of 14 feet.

The sludge is forced out of the sedimentation tanks by the hydraulic head and flows through an open conduit, through the bottom of which air is admitted to keep the sludge in suspension and prevent it from settling in the conduit. Part of this sludge is sent to the filter presses and the remainder is returned to the aerating tanks, both parts being delivered by pumps. Under normal conditions 18 per cent of the activated sludge will be returned to the aerating tanks, but this can be greatly increased without interfering with the process. During Sundays and holidays, when the sludge presses and drying plants will be shut down, all the sludge, estimated to amount to 12,000 gallons per million gallons of sewage, will be returned to the tanks.

The sludge which is not returned to the aerating tanks will have sulphuric acid added to it at an average rate of 4.5 c.c. per gallon of sludge to facilitate the dehydrating of it. A stuff pump will force the acidulated sludge into filter presses, where it will be reduced to a water content of 80 to 85 per cent., the water expelled by the press flowing back into the low-level sewage, to again pass through the plant. This sludge is mixed with the screenings from both the fine screns and the coarse screens, the former having first had their water content reduced to from 80 to 85 per cent by passing them through still rolls, and the coarse screenings having been passed through a press of the cider-press type. The mixture of screenings and sludge cakes will be carried to driers by a grab bucket operated by an electric hoist. The driers will be of the continuous, revolving, and either direct or direct-indirect type, 60 feet long by 82 inches in diameter, each guaranteed to be capable of reducing the moisture of one ton of sludge per hour from 85 per cent to 10 per cent with a fuel combustion of one pound for each 3 pounds of water evaporated.

The sludge and screenings, reduced to 10 per cent moisture content, will then be screened through a shaker screen having 10 meshes to the inch, the matter which fails to pass the screen being ground and rescreened. The matter passing the screen will be ready for sale and will be conveyed to storage hoppers which will have a capacity of ten days' output. These hoppers will deliver their contents into bags, being arranged for automatically delivering a fixed amount into each bag and recording the number and weight of the bags filled. The bags will then be carried by a bag conveyor to a car-loading platform or a storehouse.

The grit settling in the grit chamber will be removed by a clam-shell bucket suspended from the end of a 50-foot boom operated by a ten-ton locomotive crane and will be deposited back of the bulkheads along the dock line for filling in low land adjacent to the plant. The grit chambers are protected from being damaged by the bucket by a floor of steel rails 15 inches apart and ½ inch above the concrete bottom.

It is estimated that the coarse screenings collected will amount to 0.022 cubic yard, or 0.02 ton per million gallons of sewage; that the grit will amount to 2.3 cubic feet per million gallons; the fine screening 618 pounds at 87.2 per cent moisture; the excess sludge, 12,100 gallons at 97.5 per cent moisture, or 102,850 pounds, with a specific gravity of 1.02; sludge cake, 10,083 pounds at 80.3 per cent moisture; and dried sludge, 2,521 pounds at 10 per cent moisture.

It is planned to provide 1.5 cubic feet of air per gallon of sewage, based on the average dry-weather flow, which includes the air applied at all points. The pressure of the air will average 7 pounds.

The power necessary for operating this plant is estimated at 11,835 horse power for the 1950 volume of flow, which is being divided into 805 horse power for operating the low-level centrifugal pumps, 10,057 horse-power for the blowers for compressing air and auxiliaries, and 973 horse power for the generators for operating miscellaneous motors for all purposes connected with the plant.

ESTIMATED COST

Estimating the cost of any plant to be built during the next three or four years is difficult if not impossible with any confidence as to its accuracy, but Mr. Hatton estimates the cost of a plant with a capacity of 85,000,000 gallons adequate for the year 1930 at $5,000,000. This total, however, includes considerable provision for extension of the plant to meet the 1950 volume of flow; 17 of the 22 acres covered by the plant must be recovered from the lake at a cost of more than half a million dollars; all structures must be supported upon pile foundations using 25-foot to 40-foot piles driven on 4-foot centers, and the materials and labor have to be estimated at 80 to 100 per cent more than pre-war costs.

The annual cost is estimated to be $33.58 per million gallons of sewage treated, $14.07 of which is capital charges and $19.51 is operating costs. The latter are based on paying labor $4 a day, 0.75 cents per k.w.h. for electric current, $4.75 per net ton for coal, 20 cents each for burlap filter bags, and 1 cent per pound for sulphuric acid.

On the basis of the experiments it is estimated that one ton of dried sludge will be obtained per million gallons of sewage and that the sludge will contain an average of 4.5 per cent nitrogen as ammonia, worth $4 per unit. This estimate is believed to be conservative, since the sewage treated in the demonstration plant has produced 1¼ tons of dried sludge per million gallons and has contained about 5.5 per cent of nitrogen as ammonia, and the present quotation is now $6.50 instead of $4 per unit. This estimate of returns would give $18 per ton, or per million gallons, which is $1.51 less than the operating cost or $15.58 less than the total cost. This net cost is considered by Mr. Hatton to compare favorably with that of any other type of treatment producing a comparable effluent.

RESULTS OF TEST

A great deal of valuable information will be given to the engineering profession when the results of this long and thorough investigation are made public, as we presume they will be. Special investigations were made of screens, sedimentation tanks, methods of de-watering and drying sludge, and scores of minor points.

In connection with the screens, tests with band screens containing ⅛-inch slots and others containing 3-32-inch slots show that the ⅛-inch slots would pass about 20 per cent more sewage than the narrower ones, but collected 30 per cent less screenings. The effluent from the finer screen could be treated at a higher rate per acre, which would thus reduce the cost for aeration tanks. Undoubtedly a still finer slot would have increased the amount of screenings removed, but it was found that the sludge obtained from sewage which had passed through screens finer than 3-32-inch did not contain sufficient coarse matter to permit de-watering the sludge readily, it being found that sludge should contain coarse matters, hair, etc., to afford vehicles by which the water could be led from the interior of the sludge cake to the outer surface.

Aerating tanks 10 feet deep and others 15 feet deep were experimented with, and it was found that the latter gave somewhat better results in addition to requiring less area of plant.

During four months the same sewage was run through two tanks, one having one square foot of filtros plate area to 4.4 square feet of tank and the other one square foot to 6 square feet of tank area. The former gave so much better results that the ratio of 1 to 4.5 was adopted.

Investigations of sedimentation tanks conclusively indicated that satisfactory sedimentation could be effected at the rate of 1,800 to 2,000 gallons per square foot of tank area; also that the minimum depth should be 15 feet when treating ordinary fluctuating flow, since the fluctuation caused the fine sludge zone to rise from 2 feet during low flow to 13 feet during maximum flow; and that the flowing-through velocity should not exceed 1.5 feet per minute.

It was found that the sludge should be given at least an hour's time for settling. If removed as fast as it accumulated it would have a moisture content of 99 or 99.5 per cent, whereas after an hour or more of settling this would be reduced to 98 per cent, or to from one-half to one-quarter the quantity. This was effected in the test plant by the use of a plow or scraper which forced the sludge to a central opening in the bottom of the tank, but which allowed the two or three feet of sludge above the plow to remain in the tank. To secure this result it was found that the speed of the plow should not exceed 13 feet at any point.

One of the most difficult problems was and may continue to be the de-watering and drying of the sludge. Three types of press and two types of centrifuges were experimented with, together with numerous details as to filter cloths, feeding devices, etc. No success whatever was obtained with centrifuges, and the best results were obtained with the plate press made by the Simplex Company of Chicago, and the platen press made by the Worthington Pump and Machinery Company of New York and known as the Berrigan press. Experiments are still being conducted with a type of filter plate made by the John Johnson Company of Brooklyn, N. Y., and with the one used in the sewage disposal plant at Worcester, Mass.

In order to prevent nuisance by the odors arising from the drying of the sludge, it is proposed to install a method tried out at the experiment station, by which the gases are drawn through a dust chamber and thence through a spray washer, the water containing soluble gases being discharged into the low-level sewage.

The Florida state road department is making tests of available materials and mixtures to determine the most advantageous design for concrete pavements that will be laid over 1,700 miles of highway there.

Pneumatic Caisson Tunnel Shafts

Steel concrete 34x62-foot double shafts sunk 80 feet for installation of eight shields for excavating tunnels under East River at 14th street, New York. Walls built and sunk in successive operations. Roof of working chamber three times placed and removed.

Section 3 of the 14th Street-Eastern Subway for the Rapid-Transit System of New York City, consists of a pair of twin tube tunnels, about 12 feet apart in the clear, that cross under the East river from 14th Street, Manhattan, to Brooklyn. Each tube has a segmental cast-iron shell lined with concrete with a clear inside diameter of 15 feet or 15 feet 6 inches.

The tunnels were driven by the pneumatic process by means of eight excavating shields, four of which were installed at the foot of a shaft near the bulkhead line on the Manhattan side of the river, and the other four from the foot of a similar shaft near the bulkhead line on the Brooklyn side of the river.

These shafts were substantially duplicates, and each consisted of a rectangular 34 x 62-foot steel box 80 feet deep from a few feet below the surface of the ground to below the tunnel invert, and divided into two equal symmetrical wells by a center transverse wall.

All of the walls consist of an inner and outer skin of steel face plates 5 feet apart connected by systems of stiffener trusses and girders, and all of the walls are filled solid with concrete. In the outer walls the vertical external plates extend to the steel cutting edge riveted to them and to internal face plates that, at the lower part, form an inclined surface intersecting the horizontal roof of the working chamber 7 feet above the cutting edge, above which the inner face plates are vertical and parallel to the outer plates. The transverse partition wall, however, extends only a short distance below the roof of the working chamber, leaving the latter entirely unobstructed over the full area of the caisson.

Besides being used for construction purposes and for the handling of materials in and out of the tunnels, the shafts will, after the completion of the tunnels, remain in service as permanent ventilating shafts and for emergency exits and will eventually be supplied with forced draft ventilating equipment for use in emergencies.

The shafts were built and sunk as a part of the general tunnel contract, which was awarded to Booth & Flinn, Ltd., in February, 1916, on a unit price basis which it has been estimated will bring the final cost to the city to about $6,500,000.

ERECTION OF CAISSONS.

Operations were commenced at about the same time on both sides of the river by the excavation of pits slightly larger than the lateral dimensions of the caissons, that were carried down to about ground water level, a depth of about 10 feet below the surface of the Manhattan side where slight pumping was necessary, and to a depth of 5 feet on the Brooklyn side. Each site was commanded by a pair of wooden stiffleg derricks with 60-foot booms, each of which operated a 1-yard clamshell bucket with which the earth was removed.

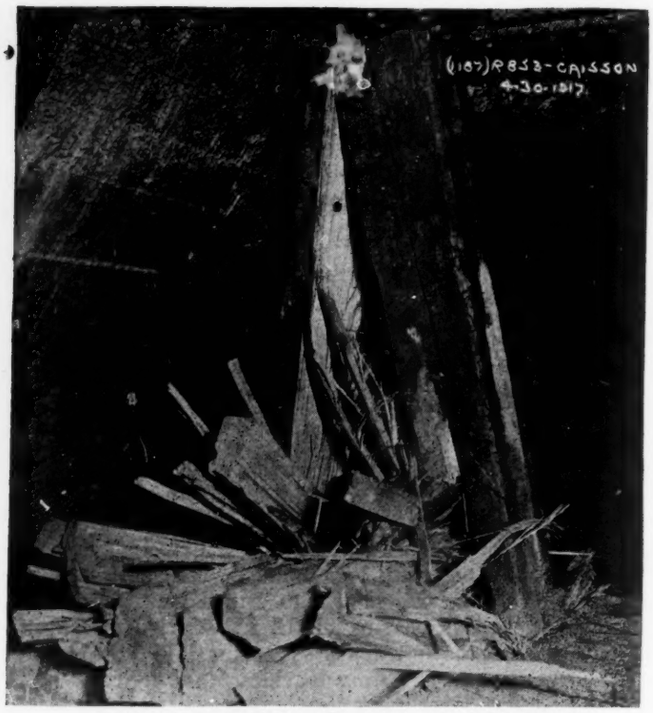
In the bottom of each pit the cutting edge was assembled and on it the walls were erected, the inner wall being, for convenience, supported on vertical shores or pump logs about 6 feet apart on centers, that were provided with 4-inch jackscrews at the lower ends bearing on 12 x 12-inch timber sills wedged up on transyerse beams laid in the bottom of the pit, and thus providing for the direct support of the steel work independent of the sloping inner wall of the working chamber and also furnishing a convenient method for adjustment and the correction of settlement.

The steel, fabricated at the Ambridge plant of the American Bridge Company, was delivered by lighters and was assembled by the two booms of the derrick tower shown in the illustration.

In the first operation, the walls were carried up to about one-third of their final height, and on the east and west sides of the caisson, just above the cutting edge, there were provided four circular steel bulkheads of a diameter 2 feet greater than the external diameters of the tunnels. These bulkheads were practically sections of the regular outer walls made with special beams and stiffening trusses connecting the inner and outer plates, and bolted, instead of riveted, to the main walls to provide for their easy removal. All the rest of the assembled pieces were riveted in position, and the seams were calked with pneumatic tools as fast as the work progressed. The calking tools and riveting hammers were operated with compressed air furnished by the plant installed for the pneumatic tunnel work.

CAISSON SINKING.

The work was carried on with an average force of about 100 men, and as soon as the caisson on one side of the river had been built up to a given height, the steel men were transferred to the opposite shore to work on the caisson there, while the caisson they had just left was sunk by interior excavation under air pressure. By the time the second caisson was built one-third of its height, the sinking of the first one had progressed a corresponding amount and the roughnecks and sand hogs were shifted, each replacing the other, and a new section of steel was built on the first caisson while the second was lowered, and so on, alternating until



SHORE CRUSHED BY SETTLEMENT OF CAISSON

both caissons were sunk to the required depth of about 80 feet, the work being commenced in December, 1916, and finished in April, 1917.

Most of the material was excavated by hand, loaded in buckets and hoisted through the air shafts and muck locks by the booms of the derrick towers, which swung loaded buckets over the tops of the caisson walls and emptied them into hopper bottom elevated storage bins from which the muck was easily delivered to trucks that disposed of it. A small portion of the material, especially on the Brooklyn side, was mud which was ejected from the working chambers through the blow-off pipes.

SKIN FRICTION.

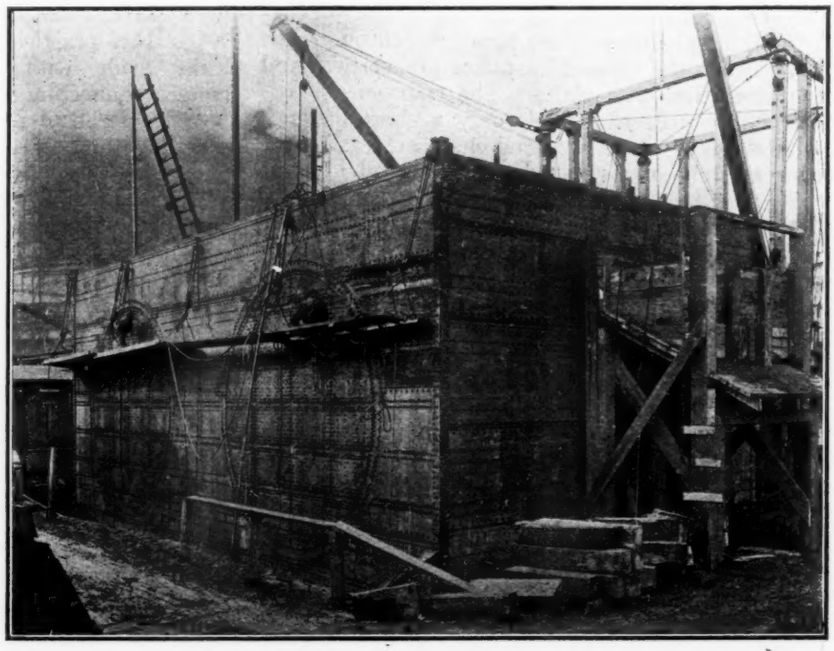
As the caissons descended and the skin friction on the exterior increased, it was necessary to add to their weight in order to keep them in motion and water ballast was accordingly pumped into the walls above the working chamber as required and was supplemented by cast-iron weights.

Although the caissons were nominally duplicates, considerable difference was experienced in sinking them, and that on the Manhattan side, which was sunk 2 feet deeper than the Brooklyn caisson, required a total weight of about 7,428 tons, composed of 1,700 tons of caisson steel, 4,600 tons of concrete, 600 tons of water ballast and 1,528 tons of cast-iron ballast. The Brooklyn caisson required, on the contrary, a total of only 6,445 tons, composed of 930 tons of caisson steel, 4,650 tons of concrete, 150 tons of water ballast and 715 tons of cast-iron ballast. This discrepancy is probably accounted for by the difference in the soil and by the fact that rock was encountered by the Manhattan caisson and not by the Brooklyn caisson and that the passage through the rock was easier than that through the earth. Some advantage was derived from the use of water ballast on account of its convenient loading and unloading, and because it provided a uniformly distributed load on the top of the working chamber roof to balance the pneumatic pressure on the lower side. The most rapid progress made was sinking 4 feet 8 inches in 24 hours for the Manhattan caisson.

CAISSON PRESSURES.

The highest pressures involved were 39½ pounds per square inch above atmospheric in the Manhattan caisson and 22 pounds in the Brooklyn caisson, both of which were developed during the sealing of the working chamber.

In accordance with the strict requirements of the New York State law, the length of the shifts for the sand hogs varied from 8 hours for pressures of 22 pounds or under to 6 hours for pressures of 22 to 30 pounds, 4 hours for 30 to 35 pounds, and 3 hours from 35 to 40 pounds. These shifts were, however, divided into two working periods, the longest being 5 hours for the lowest pressure, and the shortest being 1½ hours for the highest pressure, with an interval of at least 3 hours for rest and decompression between shifts. When the pressure exceeded 35 pounds, the work was



GENERAL VIEW OF CAISSON AT FOURTEENTH ST. AND AVENUE D, MANHATTAN, FOR SUBWAY TUNNEL CONSTRUCTION

carried on by 8 shifts, each consisting of two 1½-hour periods. Great care was taken to prevent too rapid decompression when the men emerged from the caissons, and no serious cases of the bends were developed. The contractors, however, maintained on each side of the river a hospital air lock, physician, and attendants.

The legal requirements for decompression are that the time in minutes shall be twice the pressure in pounds, divided by 3, until the pressure reaches 36 pounds, and that for each additional pound over 36 pounds, 1 minute shall be added.

The positions of the caissons were carefully located and little difficulty was encountered in sinking them accurately. When the Manhattan caisson had nearly reached its final position, the roof of the working chamber was shored up at one point to correct a little too rapid settlement there and the heavy pressure caused one of the vertical timber supports to be crushed, as shown in the accompanying illustration, but no damage resulted and there was no material displacement of the caissons.

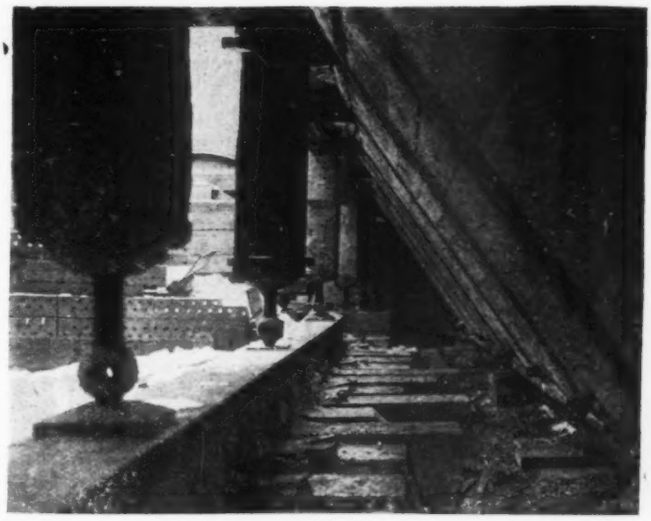
At each caisson there was installed a 1-yard concrete mixer delivering to steel buckets that were handled by the booms of the derrick tower, and dumped into distributing hoppers from which short wooden chutes conveyed the concrete to the required positions in the walls.

After the caissons were sunk and the bottoms satisfactorily prepared, the working chambers were concreted under air pressure to a minimum thickness of 5 feet at the center of each compartment forming heavy floor slabs, horizontal on the bottom, and with the upper surface making groined arches 7 feet thick under the outer walls of the caisson and under the transverse partition wall, which was given bearing on the concrete slab.

INSTALLATION OF TUNNEL SHIELDS.

After the bottoms of the caissons had been concreted, the roofs of the working chambers were

OLD CRIB TIMBERS ENCOUNTERED IN WORKING CHAMBER



INNER WALL OF CAISSON ADJUSTABLY SUPPORTED DURING ERECTION

separated into 6 x 3 foot panels of buckle plates and the girders were detached and removed. Wooden cradles were then provided on the concrete bottom and on them were erected in each well of the shaft a steel shield 18 feet 5½ inches in diameter, 15 feet 3¾ inches long, with a skin 2 inches thick and weighing altogether 104 tons. After the shields were completed the roofs of the working chambers were reassembled and connected to the walls of the caisson about 25 feet apart above their original position, clearing the shields, and pneumatic pressure was re-established under the roof.

The circular bulkheads opposite the forward ends of the shields were then carefully removed and the shields were driven through the openings thus provided by the operation of seventeen 8-inch hydraulic jacks of 125 tons capacity operating on each shield and reacting against a special framework built to receive them on the opposite caisson wall. In each case the two shields in the foot of the same caisson were started in opposite directions, one toward the river and the other toward the shore. The air pressure of between 30 and 40 pounds was maintained in the bottom of the shaft until the shields had advanced about 150 feet, when air locks were built in the completed portions of the tunnels in the rear of the shields, permitting the air pressure to be maintained at the shields and released in the foot of the shafts.

The working chamber roofs were again removed in the shafts and the second pairs of shields were constructed in the bottoms of the shafts, headed in the opposite directions to those first constructed, the roof again replaced and air pressure re-established, the remaining circular bulkheads removed, and the last four shields driven through the sides of the shafts and into the ground beyond, as already described. When they were sufficiently advanced, air locks were built in the completed tunnels behind them, the pressure released in the foot of the shaft and the working chamber roofs again and permanently removed.

The shields were built by the American Bridge Company, and about 6 weeks was required to get each set of them assembled, riveted and started on its excavation.

The work was done under the direction of Chief Engineer L. Turner, Tunnel Engineer C. M. Holland, Resident Engineer William McK. Griffen, and Superintendent Michael Quinn.

A Platform For American Industry

A statement of principles urged by the National Association of Manufacturers for adoption by the National Political Parties.

At the New York twenty-fifth convention May 18 of the National Association of Manufacturers there was adopted a "Platform for American Industry," to be submitted to the Republican and Democratic conventions for incorporating in their national platforms.

It calls for the liberation of American industry from the "many obstacles now created by unnecessary regulation," and is intended also as a challenge to the American Federation of Labor. In presenting its platform the Manufacturers' Association calls upon the people to choose between its platform and the principles of the federation.

The principal planks include Industrial Bargaining, Immigration, Government Ownership, and Regulation of Combinations. Special attention was called to public feeling against union methods:

The passage of the Adamson act by the intimidation of Congress was the turning point in the alienation of public sympathy for unionism. The loss of the steel, coal and police strikes and the failure of Congress to put plums in the Plumb pudding is still further evidence of dislike. The public should, and it is believed can, be made to realize that nothing but a united effort of all our citizens for thrift and greater industry can prevent a financial crisis. This applies to all employes.

The right to strike or lockout, which is merely an exercise of the right to act in combination, must be defined and limited wherever it conflicts with the community's paramount right of self-preservation. It is therefore essential:

1. That the national and state governments, each in their respective fields, shall assert and establish effective control over combinations operating in production and transportation essential to the life of the community.

2. The public interest requires that the possession and exercise of power through combination shall be accompanied by corresponding responsibility. Every association, whether of employers or employees, must be equally subject to public authority and legally answerable for its own conduct and that of its agents.

3. The life of government is its power to function. The right of government employes to adequate hearing and just and generous treatment must be amply protected, but the right of such employes to combine to stop or obstruct the operation of government does not exist.

4. The paramount common interest in continuous public utility service empowers and obligates the government to control all combination to paralyze or obstruct it and requires the ultimate submission of disputes threatening the interruption of such service to impartial adjudication without depriving the community of it.

5. To preserve equality before the law, the same principles of conduct must apply to all classes of citizens under like circumstances. To make or propose to make it right and lawful for one class of citizens to do that which is unlawful or crimnial when done by another class, or to prohibit or pretend to prohibit the use of public funds to enforce any law against an excepted group of possible offenders, is vicious. It should be condemned in principle and offending enactments repealed.

The platform urges readjustment of railroad rates "to save the country from irreparable injury." Compulsory arbitration is advocated to prevent railroad strikes.

"A constructive policy of selective immigration" is urged for the purpose of replenishing the country's labor supply. The general prohibition of immigration is branded as "a counsel of bigotry and selfishness." Careful examination of all prospective immigrants, both abroad and upon entering the country, is urged, as well as a constructive program of distribution of immigrants and their Americanization.

An attack upon the American Federation of Labor on the ground that many of its policies are "inimical to the public good" was made in the report of the committee on industrial betterment and safety, which was adopted and ordered incorporated in the record of the convention.

Union labor has defiantly challanged all opponents to its ambitions in the coming elections.

Many of the leaders of organized labor, the report asserts, urge violence as a means of settling industrial disputes. The entire federation is arraigned on its principles, and the report concludes that it is impossible for leaders of industry to cooperate with union officials because of the alleged stubborn and dogmatic stand taken by them.

The report demands the incorporation of unions so that they may be held to the same responsibility as industrial and financial corporations.

"The union policy of equal compensation for classes, regardless of individual ability, under the guise of common brotherhood and the restriction of output," the report says, "is a blight on the membership, destructive to loyalty, deteriorating to capacity and creative of dishonesty, dissatisfaction and unhappiness."

The desperate need of housing in New York City needs no emphasis to be understood. Yet when Mayor Hylan recently proposed to raise $100,000,000 for building new residences and asked for cooperation by capital and labor, union labor responded by requiring $1.25 an hour and the destruction of all partially completed non-union construction before union reconstruction would be commenced.

The destruction of perfectly good completed work to induce union labor to reconstruct is an act of imbecility and a financial crime that should be made legally punishable.

It must be apparent that the interests of employers and union officials are absolutely incompatible and that further effort to cooperate with these officials is not only impossible, but unwelcome to them.

What this country now needs is one of our war drives —a national campaign for industriousness, thrift and common sense. A work slacker is no better than a soldier slacker.

An honest day's pay for an honest day's work, and an honest day's work for an honest day's pay, is the simplest and best platform for employer, employe and the public alike.

Portland Building Zone Ordinance

This ordinance has been adopted by the City Planning Commission, and will be submitted to the voters in November, calling for eight kinds of Use Districts, and six of Height-of-Buildings Districts. Comments from other cities are added.

The matter of city planning has been under consideration for some time in Portland, Oregon, and the results of the work of the commission in planning street lay-outs were described at some length in Municipal Journal and Public Works for August 23 and 30, 1919. Along the same progressive lines has been the work of the City Planning Commission in preparing a building zone ordinance, which was finally adopted on March 17 of this year and will be voted upon at the general election next November.

As in the case of the street planning work of the commission, tentative regulations of a proposed building zone ordinance and lay-out of zones of different classes were prepared by the commission and then presented before meetings of property owners of the various sections of the city, more than 150 of such neighborhood meetings and conferences having been held. A representative committee of property owners in each neighborhood combined with the City Planning Commission to evolve a preliminary zoning plan, which was later ratified at a neighborhood meeting to which all property owners of the district were invited. These neighborhood plans were later pieced together to make up the general preliminary zoning plan for the city.

As finally reported to the City Council, the zoning ordinance provides for eight kinds of "Use Districts" and six classes of "Height-of-Buildings Districts."

Of the Use Districts, Class 1 is for single-family dwellings, churches and schools only. At present approximately 86 per cent of all the buildings in Portland are single family dwellings, and two-thirds of the area of the whole city is set aside for Class 1 districts.

Class 2 are residence districts in which any kind of flats, hotels or apartments are permitted. Buildings of this type actually cover today an aggregate of about 250 blocks, and the ordinance provides for 1,250 blocks of this class, besides permitting this type of building in more than 800 additional blocks of Classes 3 and 5. These districts are generally established around the central core of the city, and in numerous small districts throughout the outlying sections.

Class 3 is for all ordinary stores, trades and professions, including any of the dwellings of Classes 1 and 2. This class was to cover the downtown retail center and a number of such centers which desired to keep out the public garage and other businesses which interfere with the best retail store development.

Class 4 is for public and semi-public buildings, schools, churches, playgrounds in parks, airplane landing fields, libraries, fire-houses, green-houses, etc.

Class 5 permits any kind of new retail or wholesale business, warehouses, public garages, dyeing and cleaning establishments, undertaking parlors, etc. This class will be located surrounding the downtown retail center, and at practically all existing local business centers at cross-roads, about every half-mile conveniently located throughout the outlying residence districts.

Class 6 is for hospitals, sanitariums, clinics, day nurseries, homes for the aged or children, and other charitable institutions. In a few cases where good home neighborhoods have been invaded by such institutions and property owners have vigorously protested against making them permanent, they will either have to seek a new location or convince their neighborhoods before they can be enlarged.

Class 7 is for all ordinary but not obnoxious industries, warehouses and factories, but excluding new residences of any kind. These districts will include approximately 6,000 acres within the city limits. The exclusion of residences from these districts is similar to the practice adopted for Alameda and Newark.

The Height-of-Buildings Districts are divided into 2½-story, 3-story, 4-story, 6-story, 8-story and 10-story districts. A few buildings of 14 and 15 stories already exist in the central downtown retail district, which is made a 10-story district, but the assessor and owners of property testified that these high buildings were not profitable and were objectionable as cutting off light and air from their neighbors. As in other cities, towers, gables, grain elevators, etc., can exceed the high limit, provided they set back one foot for each additional foot of height above the height limit and do not cover more than 2,500 square feet on the base area.

It is provided in addition provided that in Class 1 new dwellings can cover not more than 40 per cent of the area of the lot at grade nor more than 30 per cent above a level 16 feet above grade. Practically all the homes of these districts at present cover only 20 to 25 per cent of their lots.

ZONING IN OTHER CITIES.

During discussions of the zoning ordinance before the City Council, it was thought desirable to

determine how similar ordinances had worked in other cities. Mayor George L. Baker wired the mayors and realty boards of a number of principal cities, asking their opinions on this point.

The mayor of Oakland, where a zoning ordinance has been in effect since April, 1919, reported "Results satisfactory to everyone." The city clerk of Los Angeles—"Working satisfactorily." Los Angeles Realty Board—"This board favorable to building zone regulations and believes them advisable." Henry W. Kiel, mayor of St. Louis—"It has protected residential districts from invasion of inappropriate structures, and seems to have general approval." J. H. Farish, president, St. Louis Real Estate Exchange—"The zoning regulations adopted two years ago are not popular with many real estate agents since they prevent the indiscriminate sale of vacant lots for every use. They have considerable merit in that they prevent the invasion of apartments or business buildings in residential districts. I am not of the opinion that they stabilize values or help conditions."

Charles E. Hewes, city manager of Alameda, Cal.—"Zoning ordinance in effect just one year. Already we see beneficial results, especially in regard to protection of homes and houses—general satisfaction expressed throughout the city." H. U. Nelson, secretary, Minneapolis Realty Estate Board—"Minneapolis Realty Estate Board is a unit in believing that zoning conserves real estate values and promotes an economical and logical growth. We are trying to obtain a zoning plan for Minneapolis. Minneapolis is going to have a comprehensive zoning plan if it has to elect an entirely new City Council to get it."

A. W. Stanmeyer, president Cook County Real Estate Board—"Common Council of Chicago today unanimously approved building zoning ordinance proposed by this board." (Sent February 18, 1920). Richard O. Chittick, executive secretary, Real Estate Board of New York—"Majority public sentiment here approves zoning plan and general effect is undoubted stabilization of values and rents."

Planning Houston's Port

Whereas, most American ports have grown without any definite plans and are consequently in many respects inadequate to accommodate the increase in traffic, those in charge of the development of the Port of Houston intend to build with an eye to the future.

A definite plan has been worked out within the last year. The sharp curves in the inland channel are to be reduced, and the radius of curves increased from 2,500 to 3,000 feet. It is planned to build turning basins at several points along the inland portion of the channel. The establishment of harbor lines will prevent the encroachment of wharves upon the channel proper.

A belt railroad will be built on each side of the harbor, with spur tracks extending to industrial plants and wharves. An effort will be made to get from the state legislature 3,600 acres of submerged lands as sites for industrial plants. The effort is being made in every way to facilitate the movement of vessels, cars and freight.

Rising Prices Halt Detroit's Sewer Work

A shortage of material—cement, sand, gravel and brick—has brought to a standstill Detroit's huge public sewer program. One contractor has notified the department of public works of his inability to complete his job due to the increased cost of labor and material, and others are expected soon to follow the same course.

The present situation may force the city to adopt a new form of contract, recommended by the special sewer commission, providing for the payment of 75 per cent of all labor and material costs above a fixed schedule of prices made at the time the contract is let.

Since July first, contracts in the sum of $5,800,000 have been let for sewer work on which nothing has been done, according to Controller Henry Steffens, Jr., and $1,722,000 worth of work has been done in the same period.

Snow Removal in Denver

Denver's interesting periodical called *Municipal Facts* in its April-May issue states that the big snow of April 17 broke all Denver records as a heavy snow storm and also as to the time in which it was removed. The unusual speed of removing is attributed to the complete co-operation between all bureaus of the Department of Improvements and Parks. All highway trucks and teams, as well as the Park Department outfit, were used, including a number of trucks recently received from the Federal Government through the State Highway Commission and a number of heavy trucks borrowed from local construction companies. In addition to twenty motor trucks, a caterpillar engine was used. Street car lines were tied up on Saturday and the mayor ordered the downtown streets closed on Sunday to facilitate the work, and by Monday morning the snow no longer interfered with the daily industrial life of the city.

Proposed Suisun Dam

The construction of a giant dam across the Carquinez straits in Suisun bay, from Army Point to Bullshead Point, California, is the plan offered by delta interests as a solution of the present water difficulties in the lower reaches of the Sacramento and San Joaquin rivers. The dam is intended to keep the salt water from backing into the mouths of these rivers and so assure a supply of fresh water for domestic and irrigation uses.

The dam would contain locks to permit the passage of steamers of light and heavy draught. It would be about a mile long and 53 feet high. A railroad track or roadway might be built across the top.

If the dam were constructed, it is claimed, the Suisun salt marshes would become fresh water marshes and could be reclaimed for cultivation.

Japan plans to spend 350,000,000 yen during the next ten years in the construction of a deep sea harbor at Tokio to afford facilities for large vessels which now have to dock at Yokohama 18 miles away.

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Water Works Expenses and Incomes

One of the leading papers at the 1919 convention of the American Water Works Association gave the results of an investigation into the effect of the war on water works departments and companies. A paper scheduled for this year's convention entitled "The War Burden of Water Works in the United States Continues," will probably adduce later and additional facts to prove the disadvantage under which high prices and the scarcity of materials have placed practically all water works properties.

In this issue and last week's we present figures from several score of cities in all parts of the country showing the extent to which cost of construction and operation has been increased since 1914. In a general way these figures show that these costs have about doubled, on the average. It is also shown that the wages paid to water works employees have been about doubled on the average and have been increased to some extent by nearly all plants. The salaries of superintendents also have increased on the average 25 to 50 per cent.

But when we look on the other side of the ledger for the increased income whereby these additional expenses are met, we find that less than one-half and probably not more than one-third of the water companies have increased their water rates at all, and the majority of those which have made increases have kept these well under 50 per cent. The question naturally arises, how long the companies can continue under increased burdens without commensurate increases in income and remain solvent, and how long water departments can operate under similar conditions and still continue to maintain that financial independence of the municipal treasury which has come to be generally recognized as desirable and almost essential to economy of operation and business-like financing.

It would seem to be demonstrated by the figures available that, unless prices come down very soon, the remaining half or two-thirds of the plants of the country must increase their water rates by at least 50 per cent. We believe that the people have learned to appreciate the fact that the increased cost which they have experienced in their own living expenses affects all departments of industry as well, and that they will not make any serious objection to paying this increase, which is less than they have for months been paying for the other necessities of life.

Impartial Consideration of Vehicular Tunnel Schemes

The construction of a vehicular tunnel under the North river, New York, under consideration for several years, has been thoroughly and sometimes almost bitterly discussed by the public and by competent engineers. Commissions and engineering staffs have been appointed; large appropriations have been made and partly expended; and considerable investigation and research has been accomplished but no announcement has yet been made that either type or dimensions have been finally determined on.

The commission retained an eminent engineer to report on different plans offered to it by tunnel engineers and contractors, and this report recommended a specific type and dimensions of structure which followed advanced lines differing from the most common examples of subaqueous tunnel construction.

The recomended structure was strongly attacked with diverse objections, and eventually the commission announced that its construction would not be considered and gave several points in which they considered the design unsatisfactory.

In reply, the engineer who reviewed the subject analyzed the figures and results of the commission's engineers, and demonstrated that the chief alleged faults either do not exist or are common to this type of tunnel and to the type of cast-iron tunnel not rejected by the commission.

These data are entitled to acceprance until disproved and until then apparently leave the question open and the type of tunnel subject to choice governed by practical considerations.

The principal consideration is apparently that of precedent and this applies only in scale, not in the principles involved, which have already been successfully demonstrated. Decision should be made wholly on the merits of the case, and the most important elements are safety, durability, efficiency, rapidity and economy of construction.

The article in this issue makes a good case for the safety, durability and efficiency of the concrete-block type, which is applicable to the cast-iron type although not equally so for the different dimensions proposed in the comparative designs that have already been considered.

Efficiency is practically a direct function of the capacity, which varies with the dimensions and for either type can be arbitrarily fixed within certain practical limits, which are beyond the dimensions under present consideration. There are, however, no positive data existing as to the capacity that is actually required or as to its economic limit. An increased capacity is sure to be needed, but no one knows how rapidly the use will increase or what ultimate amounts should be provided for at this time. It is therefore wholly a question of judgment.

The claims that the concrete-block tunnel can be constructed more rapidly and at a lower cost than the cast-iron tunnel are well presented and appear convincing, especially under the present conditions of the labor and material markets. This question, however, will settle itself, if permitted by the simple operation of inviting bids from responsible parties, some of whom have already offered to give security for the construction of the work at prices corresponding to those already mentioned.

It would therefore appear that the simplest and most satisfactory solution of the problem is for the engineers to definitely fix the dimensions and capacity of the tunnel, and to invite competitive bids, accompanied, of course, by proper sureties, on alternative types and details that will fill all the specified requirements, and be demonstarted to possess satisfactory strength and safety.

Under these conditions, the bidder who offers to construct the tunnel in the shortest time and for the least cost, should receive the contract.

Adjusting Labor Distribution

Although there is doubtless a considerable scarcity of labor throughout the United States, the famine is much greater in some parts than in others and there is much labor that is employed on non-essential work that might better be transferred to more imperative duties, as for instance the shifting of labor producing luxuries and performing unnecessary duties required by extravagance and carelessness, to positions where they could be efficient in more necessary occupations such as agriculture, transportation and various mechanical trades.

Furthermore, laborers could be advantageously shifted from congested centers to those that are not crowded, thus greatly relieving the critical housing problem. Most important of all perhaps is the transfer of labor from congested districts and unnecessary occupations to farms where their efforts will be productive, their personal conditions much more comfortable, sanitary and contenting. The increased production thus attained will materially assist to lower the high cost of living and with it the inflated wages, while the very fact of their transfer will eliminate some of the extravagant wages that have led to so much discontent, and the changed conditions will make the lower wages that they receive give them a greater purchasing power and secure them more comfort and satisfaction.

In line with this, comes an interesting suggestion that for a fixed period, say five years, certain classes of immigrants, especially those from agricultural sections, be forbidden to remain in New York City. With a proper Federal clearing house, allied with local industries throughout the country, this arrangement could be easily effected and would work injustice to none and benefit to all. It might be carried still farther and special inducements be made for laborers to leave New York City, where there is such an intolerable scarcity of housing and extortionate rents are required, and go to the agricultural districts where their work is demanded and where there are great numbers of empty houses, 24,000 being reported from New York State and 30,000 from Michigan.

Importance of Filter Operators

The following, which appeared as an editorial in "Shop and Field News," a monthly published by the employes of the Pittsburgh Filter and Engineering Co. and edited by F. O. Leopold of that company, restates an idea that we have expressed editorially several times; but it is one that can not be stated too often or too emphatically, until such time as all water works officials realize its great importance to the citizens who depend upon them for safe water:

With the increasing number of water purification plants throughout the country, the question of qualified filter operators should certainly be given more consideration, if the most efficient results are to be obtained and a reasonable return made on public funds expended.

The day of the "handy-man" has passed and it is just as important to have a trained man in charge of your filter plant as it is in any other public position requiring a trained man. In fact, when you consider that a pure water supply is the foundation of any community and the health and welfare of your city is dependent upon one or two men for the proper operation of your filters handling a polluted water supply, it is certainly of great importance that a competent man be placed in charge.

The larger cities realize the fact and place a trained chemist in charge with properly trained operators. Is it not just as important to have qualified operators in the smaller plants?

One only needs to visit the average small town filter plant to be convinced that it is time that something was done to improve this condition.

There are of course many ways in which this could be remedied, but the most logical and quickest results could be obtained through the State Department of Health.

During the past year we have experienced an endless amount of trouble in getting operators to follow instructions given by our field engineers. Only recently we completed a very modern plant for a small city in the middle west, and within six weeks it was necessary for us to send a man back there four times to put the plant back in proper working condition, and on each trip he found that instructions had been completely ignored. This is not only one case but one of many that we can name. This evil is a useless waste of time and money and it is high time immediate and proper action was started.

Senate's Investigation of Construction Situation

The construction situation in the United States is to be investigated by a Senate Committee appointed by the vice-president, with W. W. Calder, chairman, W. S. Kenyon, W. E. Edge, E. J. Gay and J. O. Wolcott. All people possessing information regarding housing and industrial shortage are requested to communicate with the special committee on reconstruction and production, Senate Office Building, Washington, D. C.

The committee has been appointed in accordance with a resolution authorizing investigation

into the existing situation in relation to the general construction of houses, manufacturing establishments and buildings and the effects of these upon other industries and upon the public welfare and to develop such measures as it may be necessary to stimulate and encourage such construction work, to encourage investments rather than spending, and to insure cooperation between labor and persons or corporations engaged in transportation, banking or other business necessary to the development of such construction.

Harbor Strikes

The congressional estimate of the cost of strikes that have affected the coastwise steamships is that since January 1st, three strikes have tied up the lines 26 days out of 118 days and since March 13 have tied up 47 vessels and more than 200 tugs, lighters and barges. Since January 1st, 1918, the cost to the public in these strikes is $86,000,000 including $12,000,000 loss in wages, $13,000,000 loss of interest on investment and $40,000,000 loss from delay, congestion and destruction of perishable freight.

Water Rates and Salaries

Data furnished by water works officials show that superintendents' salaries have been increased in most cities, employes wages in practically all; but that, in spite of this and of increased cost of materials, rates have been raised in only about one-third of the cities, and but little in most of these.

Last week we presented a number of tables showing increase in cost of materials used in the operation of water works in all parts of the country. This week we give a table showing the increases in salaries of superintendents and wages paid to other employees, and also the increases made in water rates by the several cities during the past twelve months. Increases made prior to a year ago we set forth in a series of tables published by us in our issues of July and August, 1919.

Considering first the matter of superintendent's salaries, we find that only 11½% of those reporting have received no increase; 34.5% received 25% or less; 34.5% received an increase of between 26 and 50%; 8.8% an increase of 51 to 75%; 8.8% 76 to 100%; and 1.9% received over 100% increase. This is a better showing than we had expected, more than half of the superintendents having received an increase in salary of more than 25%.

The increase in wages of other employees was quite a little greater than that in the salaries of the superintendents, only three cities having failed to increase the wages. The increases ranged all the way from 13% to 300%. Two cities gave an average increase of more than 200%; seven per cent of the cities gave increases of more than 150%; fourteen percent gave increases of between 101 and 150%; twenty-nine and a half percent gave increases of between 76 and 100%; twenty and a half percent increases of between 51 and 75%; twenty-three and a half percent increases of between 26 and 50%; and five and a half per cent increases of less than 26%. More reported 100% increase than any other one figure. The average increase, including all the cities reporting, was 84%.

WATER RATES

In spite of the very considerable increase in wages and salaries, in cost of coal, pipe and other water works materials, the increase in rates has by no means kept pace with it. Reference to the tables in last week's issue show that in most cases there has been a material increase in cost of these materials since a year ago, that in coal having been half as great as during the five years previous. But less than ¼ of the cities report having increased their rates during the past year. It is interesting to note that this condition exists quite generally throughout the country.

Dividing the states geographically into New England, Middle Atlantic, Southern, East Central, West Central, Rocky Mountains and Pacific Coast, we find the percentage of cities in these several divisions which have made no increase in their rates to be 78, 70, 71, 78, 78, 100 and 71 respectively. The increases made in rates in the several divisions may be generally described as follows: New England—8.6 to 30¼; Middle Atlantic—10 to 50%; Southern States—8 to 20%; East Central—10 to 50%, with one city reporting 100% increase in rates with no increase in salary or wages; West Central—6 to 15%; Rocky Mountain, 0; Pacific Coast, 15 to 40%.

SUPERINTENDENT'S SALARIES

Considering the increase in superintendents' salaries for cities classified in the same way, we find in the New England States only one salary not raised, while the increases vary between 7.4% and 60%. In the Middle Atlantic States 6 superintendents did not have the salaries raised, and the raises in the others vary between 5 and 100%. In the Southern States three salaries were not raised and the increases in the others varied between 5 and 225%. In the East Central States three salaries were not raised, and the increase in the others varied between 7½ and 111½%. In the West Central States two salaries were not raised, and the increases varied between 6 2-3% and 100%. In the

INCREASES IN WATER RATES, SALARIES AND WAGES

City and State	Percentage of increase since 1914 in superintendent's salary	in wages of other employees	Increase in water rates since June, 1919
Alabama:			
Gadsden	33 1-3	100	None
Mobile	5	23	None
California:			
Palo Alto	43	40-100	28
Redlands	10	60	None
San Francisco	20	73 2-5	None
Colorado:			
Boulder	20	50	None
Colorado Springs	20	20	None
Delta	None	10—15	None
Connecticut:			
Putnam	33 1-3	157.14	8.6
Southington	40	148	None
Winsted	10	100	None
Delaware:			
Lewes	65	55	20
Wilmington	41.2	76.04	None
Florida:			
Pensacola	20	50	None
Georgia:			
Albany	40	100—200	None
Cedartown	12	50—60	8
Thomasville	83	112	20
Valdosta	25	Engineers, 70, Wage hands, 300	None
Idaho:			
Lewiston	20	100	None
Sandpoint	50	50	None
Weiser	12½	25	None
Illinois:			
Bushnell	100	...	None
Chicago Heights	50	70—100	50
Duquoin	40	110	None
Mattoon	25	70	10
Monmouth	35	40	None
Quincy	66 2-3	63 1-3	None
Rochelle	60	90	None
Rock Island	None	70 & 90	None
Sparta	33 1-3	37½	None
Waukegan	66	66	None
White Hall	7½	Reduced 33 1-3	None
Indiana:			
Columbia City	60	50	None
Delphi	33 1-3	87 1-7	None
Evansville	50	50—125	None
Garrett	40	20	None
Kendallville	88+	50—75	None
La Porte	25	100—150	None
Lebanon	50	100	None
North Manchester	50	82—300	None
Richmond	...	50—65	7
Shelbyville	13.6	50	None
Terre Haute	25	63	10
Union City	25	33 1-3	20
Whiting	...	None	100
Iowa:			
Algona	50	60	7½
Atlantic	25	45	10
Cherokee	50	56	None
Denison	15	50	15
Maquoketa	36.36	28.20	None
Sioux City	35	26	None
Kansas:			
Council Grove	50	75	None
Emporia	11 2-3	100	5
Fort Scott	100	90	None
Fredonia	50	100	None
Kentucky:			
Providence	None	33 1-3	None
Louisiana:			
New Iberia	None	75	None
Maine:			
Lisbon Falls	60	62	None
South Paris	40	100	None
Maryland:			
Hagerstown	10	50	10
Massachusetts:			
Athol	23 1-5	31 1-3	None
Cherry Valley and Rochdale	20	130	20
Cohasset	17½	100	30
Lenox	None	100	None
Mansfield	33 1-3	140	None
Maynard	33 1-3	35—40	None
Millbury	42	170	None
New Bedford	38 3-5	80	None
Somerville	34.8	86	None
Springfield	10	20—150	None
Winthrop	20	50	None
Woburn	48	125	25
Worcester	7 2-5	100+	None
Michigan:			
Battle Creek	41	120	None
Belding	78	1.87	None
Charlotte	50	50	None
Crystal Falls	25	78	None
Highland Park	75	87—190	20
Michigan (Continued)			
Lansing	50	50	None
Ludington	20	25—50	25
Manistique	91+	100	None
Onoway	40	125	None
Saginaw	None	55—180	None
Minnesota:			
Cloquet	50	100	None
Fergus Falls	None	100	...
Hutchinson	40	80	None
Lake City	27	50	None
Rochester	40	100	...
St. Peter	20	20	None
Stillwater	33 1-3	112½	None
Mississippi:			
Canton	175—225	100	None
Greenwood	70	100	15
Jackson	5	25—100	None
Missouri:			
Chillicothe	50	60	None
West Plains	20	20—40	None
Montana:			
Havre	33 1-3	90	None
Nebraska:			
Hastings	50	70	10
New Jersey:			
Bridgeton	20	175	None
Hawthorne	50	50	50
New Mexico:			
Roswell	None	30	None
New York:			
Albany	None	5—86	50
Norwich	None	196 1-3	40
Ogdensburg	6 2-3	178	None
Potsdam	20	100	None
Syracuse	5	15—150	None
Watervliet	None	None	Decreased 10
Wellsville	100	100	10
North Carolina:			
Charlotte	16 2-3	35—175	None
Henderson	50	100	None
Raleigh	10	25—100	None
North Dakota:			
Valley City	25	...	None
Ohio:			
Barnesville	30	50	50
Coshocton	75	50	None
Delaware	15	60	30
Franklin	50	50	None
Lakewood	60	71—133	None
Martin's Ferry	100	50	None
Newark	15	75	None
Niles	100	160	None
Toronto	100	100	None
Van Wert	25	25	None
Wilmington	111.54	85.94	None
Oklahoma:			
Perry	50	100	15
Sapulpa	20	20	45
Oregon:			
Eugene	43	75—100	15
Portland	16 2-3	50	None
Pennsylvania:			
Clearfield	100	125	...
Indiana	None	33	None
Lebanon	None	100	None
Reading	None	100	None
Sewickley	80	250	None
Sharpsville	20	150	None
Stroudsburg	20	50	None
South Carolina:			
Newberry	52	52	Reduced 10 5 raise on min.
Tennessee:			
Dyersburg	50	50	None
Murfreesboro	100	100	15
Texas:			
Georgetown	9½	25	None
McKinney	66	40	None
Stamford	None	100	None
Taylor	20	50—100	None
Temple	6 2-3	65	None
Waco	15	50	None
Virginia:			
Charlottesville	None	125	None
Richmond	None	40—50	None
Washington:			
Auburn	50	63	40 reduction
Chehalis	26.6	50—100	None
Wisconsin:			
Jonesville	50	140	None
Oconomowoc	30	78	None
Wyoming:			
Cheyenne	16 2-3	100	None
Green River and Rock Springs	59	58 1-3	None

Rocky Mountain States two were not raised, and the increases varied between 12½% and 59%. In the Pacific States all salaries were raised, the increases varying between 10% and 50%.

WAGES

In the matter of wages, all New England cities reporting raised the wages of their employees from a minimum of 31.2% to a maximum of 170%. In the Middle Atlantic States only one city has not raised wages, the increases varying from a minimum of 5% to a maximum of 250%. In the Southern States all cities report raising wages, from a minimum of 23% with a maximum of 300%. In the East Central States, one city reports decrease in wages and another made no change, while the remainder report increases varying from a minimum of 20% with a maximum of 300%. In the West Central States all cities report raise in wages, from a minimum of 20% to a maximum of 112½%. In the Rocky Mountain States all cities report raise in wages, from a minimum of 10% to a maximum of 100%. On the Pacific Coast all reports raise in wages, from a minimum of 50% to a maximum of 100%.

Dividing the increases into those less than 26%, 26 to 50%, 51 to 75%, etc., we find increases as follows, grouped geographically:

	1% to 25%	26% to 50%	51% to 75%	76% to 100%	101% to 150%	151% to 200%	201% and more.
New England	..	17	6	39	28	10	..
Middle Atlantic	..	23½	6	35	12	17½	6
Southern	5	5	32	21	21	..	5
E. Central	4¼	30	17	25½	17	6¼	..
W. Central	8½	21	29	37½	4	..	..
Rocky Mt.	30	30	10	30	..	..	..
Pacific	..	14	71	15	..	..	..
Entire Country	5½	23½	20½	29½	14	5½	1½

Concrete Block Vehicular Tunnel Investigation

Development of proposed plan. Governing conditions. Plans for design. Advantages of Precast Concrete Block shell. Objections to concrete blocks refuted. Adverse Analytical hypotheses untenable. Capacity, stresses, strength, stability, durability, rapidity of construction, methods of construction and cost. Conclusions favor wide roadway, concrete shell without cast iron, and adoption of advanced practice effecting 50 per cent economy.

Prior to 1917 there had been proposed for the vehicular tunnel under the Hudson river between New Jersey and New York City two principal alternate types, one of them consisting of two single-way cast-iron ring tunnels similar to the existing Pennsylvania Railroad tunnels; and the other, a reinforced concrete structure built in sections on shore, floated, and sunk to place in a deep trench excavated for the purpose.

The New York State Bridge and Tunnel Commission, having studied the problem, retained General George W. Goethals to examine the different proposed plans and make a definite recommendation. From a study of these plans and all of the physical data available, it was evident that the cross-sectional dimensions required to be greater than any heretofore constructed, and General Goethals believed that they could be most readily and economically secured by the adoption of the reinforced concrete type laid under cut-and-cover conditions, provided these were found to be practicable.

TYPE RECOMMENDED

Extensive detailed studies of the bottom of the river at the proposed location were made from a large number of available data and these, together with previous experience in handling similar material, convinced General Goethals that it was exceedingly doubtful if the trench could be maintained except at expense so great as to be considered prohibitory. Further investigation was therefore concentrated on the shield-driven type of tunnels, which have already been successfully constructed both with cast-iron lining and precast concrete blocks. It was considered feasible to construct cast-iron lined tunnels of 30 feet in diameter, but, on account of war conditions, it was thought doubtful whether the cast iron could be secured when needed, and if it could be purchased except at an extremely high cost.

A preliminary study of precast concrete lining indicated a great saving in cost, and this method was advocated by the head of a firm of contracting engineers which had done more actual tunnel work in the North and East rivers than any other concern, and which was experienced with block tunnels of smaller diameters. After close study of details and an analysis of stresses for different size tunnels made with concrete block rings, General Goethals recommended their use for a tunnel of 36 feet inside

diameter with two roadway levels 24 feet 6 inches in clear width between walls and 22 feet 6 inches between curbs.

OPPOSITION TO PRECAST BLOCKS

After receiving this report, the commission issued a statement that the concrete block tunnel type would not be adopted and stated that its capacity had been greatly over estimated; that the strength of the rings is not sufficient to withstand the external load; that the construction is not suited to Hudson river conditions; that the estimates of its cost were too low; and that the tunnel could not be built within a period of three years.

After the merits of the different types of tunnels had been discussed by engineers and laymen at several public and private meetings, General Goethals requested a copy of the data from which the abovementioned conclusions had been drawn. The request having been complied with, Gen. Goethals studied these data and on April 2nd submitted to the commissions a comprehensive report on the data and on the designs for both cast-iron and concrete-block tunnels of which the following is an abstract*

CAPACITY

Previous to General Goethals report of November 24th, 1917, some engineers strongly urged provision for only single lines of traffic and there was no advocacy of the necessity of providing for more than two lines of traffic in each direction. Present ferry and bridge traffic apparently did not give a fair index of the increase to be anticipated and General Goethals deceided that a vehicular tunnel providing for less than three lines of traffic would be a mistake. He concluded that a clear width of 24 feet 6 inches between walls would be ample for 90 per cent of the traffic in three parallel lines, thus providing abundantly for actual operating conditions of two streams of traffic with cars continually swinging out and passing ahead into line. Later considerations point to the advisability of considering an increased width of 25 feet for roadways placed in two single track tunnels constructed of concrete blocks.

STRUCTURAL STRENGTH

If a given tunnel be constructed in a hole excavated larger than the exterior dimensions of the structure, the construction stresses in the latter will be different from those that would arise if the structure exactly filled the hole and continuously supported the surrounding material. In the former case, the movement of the material produces variable forces which, in the actual case of the Pennsylvania tubes, required the design to have sufficient strength to resist forces of unknown magnitude which distorted the ring and made it necessary to support the interior by means of vertical timbering or horizontal tension members, which were not always sufficient to prevent the breaking of the cast iron rings.

After the material came to rest around the exterior of the rings, the ring returned approximately to its circular form, indicating the action of forces normal to the ring. If a tunnel can be built so as to completely fill the excavated hole continually and prevent movement of the external material, the conditions will approximate those existing in the Pennsylvania tunnel after completion as indicated by recorded pressure readings.

THEORY OF STRESS

The assumptions used in analyzing the block tunnel by the commissions are based on a theory that assumes the material to be perfectly fluid, except as influenced by the friction of the individual particles of the material, and ignores the existence of cohesion; in other words, a perfectly granular material. These assumptions applied to block tunnels, for a material having a stiffness expressed by an angle of repose of 13 degress, lead to results that indicate the unsafeness and structural defectiveness of the block tunnel. If, however, these same assumptions are used in the analysis of the cast-iron tunnel during construction, either for the existing Pennsylvania tunnels before the interior concrete had been placed, or for the commission's engineers' proposed cast iron tunnel before concrete is placed, the forces are of such magnitude and of such direction that they give an unsafe condition for the cast-iron rings, in that the tension in the cast iron rises upwards of 9,800 pounds per square inch. This is an unsafe stress for cast iron, and does not allow for an increased tensile stress developed, of unknown magnitude, resulting from the kinetic energy of the material moving through the exterior space until it comes in contact with and is brought to rest by the ring.

The construction of the proposed concrete-block tunnel involves methods that result in a tunnel being built of the actual outside diameter created by the shield in its travel forward, so that the surrounding material is not allowed to move and is constantly supported as the shield moves forward. The pressure diagrams of the Pennsylvania tubes show the forces such a tunnel has to resist.

MATERIAL PENETRATED IS COHESIVE

In support of the recognition of the existence of cohesion, it may be pointed out that before any readings on the gauges could be obtained in the Pennsylvania tubes, it was necessary to destroy the cohesion of the material immediately in contact with the ring, by stirring it up with a bar passed out into the surrounding material. This fact is further borne out by the fact that segments of the tunnels have been removed and the material stands unsupported until broken down by a flow of water, destroying its cohesion.

An analysis of the forces acting on a tunnel built in such a way as to fill the annular area immediately in the rear of the tail of the shield, if applied to the existing Pennsylvania tunnels, will give pressures following very closely the pressures actually read in these tunnels.

EFFECTS OF GROUTING AND GRAVELING

During the construction of the North and East river tunnels, it was the practice to fill with grout the exterior annular space left by the shield tail. As this did not prevent movement of the earth, distortion and breaking of the cast iron ring continued. Later, the methods of forcing fine, dry gravel under high pressure into the annular space was perfected and can be used in very soft material.

*The report was accompanied by diagrams and computations demonstrating the conclusions arrived at and furnishing data for the figures given, which are consistent with this abstract but are here omitted for lack of space.

leaving the tunnel roof in solid gravel and eliminating distortion and unsafe stresses.

FLOTATION AND LONGITUDINAL STRENGTH

On the theory of driving the tunnel through granular material without cohesion, the stress sheets of the Commission's engineer show that the concrete-block tunnel is structurally sound for materials having angles of repose under 6°, but that in material of 3° angle of repose, it would float. The same reasoning shows that, under the same conditions, the proposed 29-foot cast-iron tunnel would float and that the existing Pennsylvania Railroad tunnels would have floated.

The voussoir blocks making up the concrete-block tunnel rings are bolted to each other throughout the length of the tunnel on exactly the same principle as the bolting of successive rings of the cast iron tunnel, and the bolts have a greater aggregate longitudinal strength than those of the latter tunnel. The small joints between the voussoirs are much less numerous than those between the bricks in a 2,000-foot length of the north Christopher street tunnel, built many years ago and through which trains are now operated. The criticisms that the tunnel is lacking in longitudinal strength and is impaired by dangerous small joints are not valid.

GENERAL STRESS ASSUMPTIONS

Summarizing, the above statements as to structural strength may be covered as follows:

"Theory of granular material, used by engineers, is incorrectly applied to this material, as shown by (a) Great amount of cohesion. (b) Absence of large active horizontal forces in material as shown in existing Penn. R. R. tunnels.

"We have applied theory, based on following assumptions: (a) Vertical pressure at top of tunnel equal to weight of material, (b) Algebraic sum of vertical forces equal to zero, (c) All pressure normal to surface of tunnel, (d) Pressures increase at a rate uniform for each foot of depth (determined for our computations by above assumption.) These assumptions are based on the use of gravel packing back of the shield. Comparison with pressure readings taken in Pennsylvania tubes shows variation of less than 10 per cent from results of our normal pressure formulae.

"Your engineers have applied their assuptions of granular material having an angle of repose of 13 degrees to the large two-level block tunnel, and we have checked their figures very closely. We have applied these assumptions to a smaller block tunnel having a single roadway 25 feet between curbs, to the cast-iron tunnel 29 feet in diameter recommended by your engineers, and to the Pennsylvania tubes, 23 feet in outside diameter, cast iron.

"We believe these assumptions are incorrect, but the results of computations based on them show that the tensile stresses in the 29-ft. cast-iron tunnel, and the 23-foot Pennsylvania tunnels, are far beyond the allowable safe limit for cast iron, as is likewise found to be the case for the tensile stresses in the concrete-block tunnels under the same assumptions."

Normal pressure formulae applied to these tunnels show safe unit compressions of 310, 270, 1,840 and 1,645 pounds per square inch in the 42-foot and 36-foot 6-inch concrete tunnels and the 29-foot, and Pennsylvania cast-iron tubes respectively. No tensile stress is found in any of the four types.

Cohesion of the material penetrated reduces the active pressure on the tunnel rings and increases the passive resistence. This latter is not included in Mr. Goethals theory, thus giving an additional factor of safety that exists only when packing is used. In order to break, the ring must deform; in order to deform, the ring must move against the material at some point; in order to move, it must overcome large passive forces.

The assumptions made by the commission's engineers, by which they calculated the block tunnel to be unsafe, would, if applied to the cast-iron tunnels, also show them to be unsafe.

IMPORTANT PRACTICAL CONSIDERATIONS

The joints of the tunnel will be grouted watertight, the concrete will not be deteriorated on account of reinforcement, because it does not exist, and there will be no seepage through the concrete.

The estimate of cost of a 36-foot block tunnel was basel on prices of 1917 and on the experience of the O'Rouke Construction Company, and the $12,000,000 was exclusive of the property and right-of-way.

"The cost could have been definitely settled, however, by following my recommendation to invite, from experienced parties, definite bids for specific dimensions and location, leaving the type of structure to the choice of the bidder. The failure to do this leaves the project no farther advanced than it was a year ago.

"A vehicular tunnel providing for less than three lines of traffic in each direction, if adopted, I consider would be a mistake in judgment and a lack of vision, on the part of those responsible, as to future demands of the continued growth of the cities of New York and New Jersey.

"Concrete, as a material unassisted by cast iron, is pre-eminently suitable for tunnel construction and the proposed concrete block type is sound in engineering principle, practicable to build, structurally safe, will not float or sink, and finally, is far more economical than cast iron.

"The paramount question still remains: Will your Commission, simply because fearful of attempting something which heretofore has not been tried out in its entirety, recommend the expediture of $26,000,000 to $30,000,000 to create facilities for a vehicular crossing of the North river, when $10,000,000 to $12,000,000 less than this amount will accomplish the desired end?"

Keeping Hogs, Ducks and Geese in Cities a Nuisance

The State Department of Health of Ohio, in its official publication, has registered an emphatic protest against the relaxation of the regulations which most communities have adopted preventing the keeping of hogs in towns. It considers the average pig pen as an unexcelled breeder of flies, which flies are carriers of typhoid fever and of other intestinal disorders. Moreover, the existence of filthy pig pens cannot be expected to have any effect other than damaging upon a community's sanitary standards. Commenting upon this, the Division of Health of Toledo reports that 256 pigs were

either slaughtered or removed from that city during 1919 through the activities of the Bureau of Sanitation and asserts that "the pig must go from Toledo." In this connection it says: "Another almost equally as bad nuisance as the pig is the raising of ducks and geese in the city, which was countenanced as a war measure in 1917-1918, since which time they have increased in great numbers, many people using them as a means of disposing of theirs and their neighbors' garbage. Through the effort of our inspectors this year, 442 were disposed of. The fight against the ducks and geese, as with the hog, will be carried on with greater determination in 1920."

Trees and Streets

In a discussion of the subject of shade trees before the League of California Municipalities, the action to be taken where trees and street lines interfere, and public control of shade trees, received attention.

A paper advocating ornamental shade trees for cities was read before the League of California Municipalities recently by A. E. Shamel, of the Park Board of Riverside, Cal., following which there was a discussion as to the extent to which shade trees should be controlled by the city and should be permitted to modify the development of streets, and especially roadways, for purely traffic purposes.

Mr. Shamel stated that Riverside had about 75,000 shade trees which, if placed in a continuous row, would extend more than 700 miles. This is more notable when it is considered that more or less irrigation is necessary in that section of the country for the raising of trees. For instance, 8,000 of the younger trees had been irrigated with a tank wagon three times during the week previous to the presentation of this paper. The city has appropriated $7,668 for the care of these trees this year. This work is under the care of a tree warden, who has from three to six men under him.

Following the paper, the commissioner of parks of Pasadena, J. J. Hamilton, asked concerning the desirability of leaving trees in the middle of streets, which started a discussion on public versus private control of shade trees. One member stated that, in his opinion, no tree was ever beautiful enough to leave in a street if it endangered life, and in these days of rapidly moving automobiles the question whether a tree was so situated as to be dangerous to night travel by these was the most important one.

The city attorney of Santa Barbara, W. P. Butcher, stated that the principal object of a street is travel, this being what they are designated for and laid out for. Railroads are permitted to run over them because they facilitate travel, and certain things are permitted to be placed upon them so long as they do not interfere with travel; but if anything interfered with that use of the street, it should not be tolerated. Replying to these, Mr. Shamel said that the engineer's point of view was that, when a tree is in a road, it should be cut down; while the tree lover's idea is not to cut out the tree, but to go around it—that an individual is here for 50 or 75 years, while the tree may be here for 300 or 500 years. It may be necessary to remove it, but the subject should be given great consideration, each case being studied separately.

The public control of trees also was discussed. In Los Angeles, the Board of Public Works has the power to grant a permit to take out a tree but no power to say what kind of tree shall be put in to replace it. This might result in a gradual changing of a city's plans for uniformity of shade trees, and introduce unsightly confusion. To prevent this, the Los Angeles Board will not grant a permit for removing a tree until it has received a pledge in writing that it will be replaced with the kind of tree desired by the city authorities. City manager J. W. Watson, of Glendale, stated that the city eliminated most of the opposition and discussion as to the kind of trees to be planted, by having the city furnish the trees, and plant and maintain them. It had found that the overhead cost, and loss of time and energy in discussing the kind of trees to be put in, and friction among neighbors in deciding on the kind of tree for a given street, were unnecessary and could be prevented by having the trees grown by the city in the municipal nursery at very small expense and planting the trees in a street whenever it has been improved and is ready for tree planting. As there are few trees in the city as yet, this plan distributes the benefits very equally throughout the city. In this way property owners get trees at less cost than in any other way, and there is practically no difficulty in persuading them to accept the kind of tree which the city wishes to provide and thus securing uniformity not only in kind but also in age or size of trees along a given street. The city now has about 7,000 trees in the nursery ready for planting, and expects to call upon the citizens to assist in the planting this year by having a tree planting day. In this way not only the trees themselves but their planting will be obtained by the citizens at a minimum of cost and after a uniform plan.

In San Diego the engineer has been instructed by council that in preparing plans for improving any street he shall incorporate the planting of trees, the kind of tree to be selected by the majority of the owners if they desire, or it may be selected by the engineer and street superintendent. This including of tree planting as a part of the street improvement is a new proceedure but has met with no objection in the four cases in which it has already been carried out.

In Berkeley the trees to be placed on a given street are designated by the street superintendent, a time for protest being fixed (which is quite short), and an assessment is made under the Tree Planting Act against the front footage of property after a determination by the engineer of the amount that will be necessary. The act provides that the assessment may be levied by attaching it to the tax-bill and may be paid in annual instalments instead of in a lump sum.